

FM 6-40-5

July 76

Reference

SIS FM 6-40-5

FM 6-40-5

1 JUL 76

MODERN BATTLEFIELD CANNON GUNNERY



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**THIS FIELD MANUAL SHOULD
BE USED AS A SUPPLEMENT
TO FM 6-40. IT EXPANDS ON
THE BASIC TECHNIQUES AS
THEY APPLY TO THE MODERN
BATTLEFIELD.**

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C.

1 July 1976

MODERN BATTLEFIELD CANNON GUNNERY

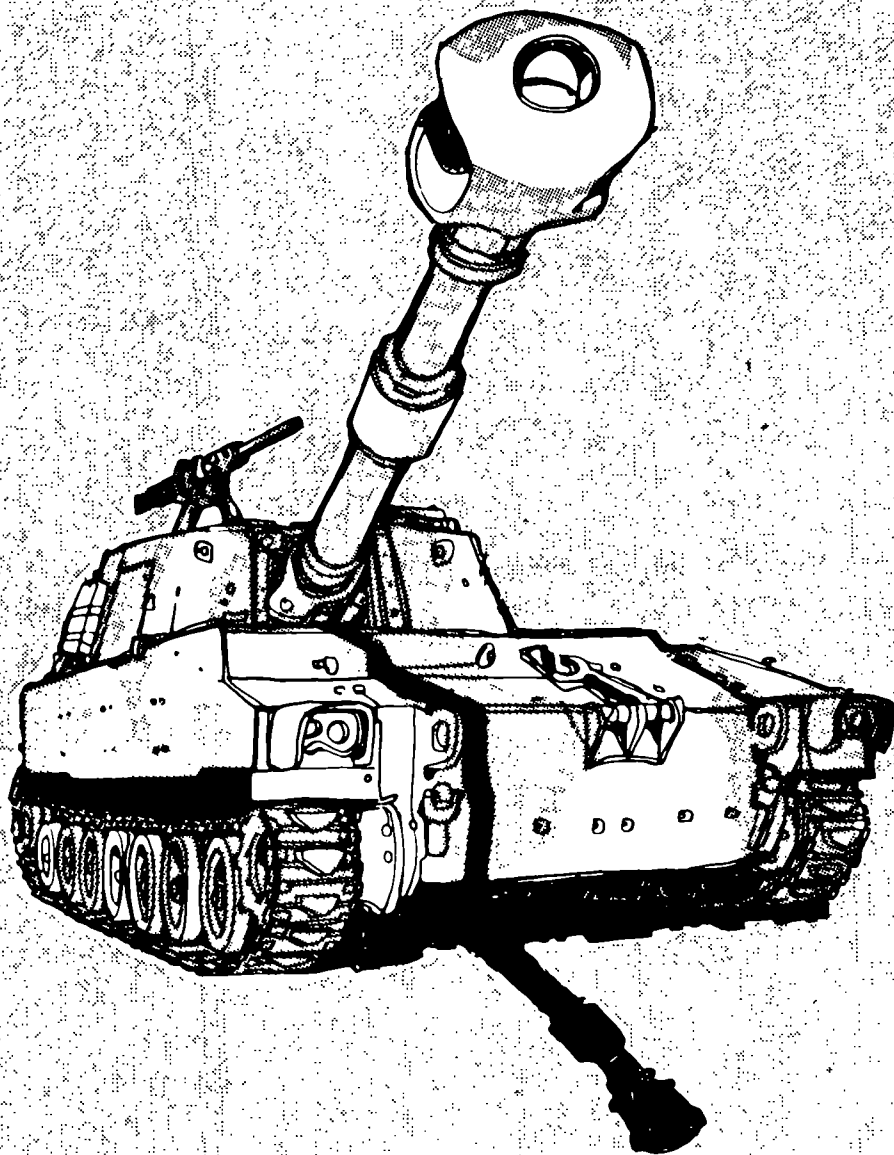
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* This manual supersedes TC 6-40-1, 30 June 1975.

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PART ONE

INTRODUCTION



CHAPTER 1

INTRODUCTION

CHAPTER 1
INTRODUCTION

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Section I. WINNING THE FIRST BATTLE OF THE NEXT WAR

1-1. Winning the First Battle

a. All our efforts must be geared toward winning the first battle of the next war. In order to win the first battle, we must be able to fight and win against an enemy that significantly outnumbers us in men and equipment. We cannot expect massive reinforcements or resupply during this first battle. We will fight with what we have when the battle starts.

b. Our maneuver forces must be able to hold key terrain, but most importantly, they, with field artillery support, must be able to inflict maximum casualties and damage on the enemy while reducing his ability to hurt us. Superior tactics and flexible systems can enable us to take the offensive at the time and place of our choosing to achieve a favorable combat exchange ratio. We achieve this high

exchange ratio by concentrating firepower and mobile maneuver forces at the critical point in time and space when we have drawn the enemy into a vulnerable position. By thus creating a locally favorable force ratio, we are able to inflict heavy damage upon the enemy.

c. Field artillery provides a major portion of the required concentration of firepower at the critical time and place in support of the maneuver forces. In addition, we suppress enemy weapons so that our maneuver forces and close air support can operate. In order to do this we must:

(1) *OPTIMIZE OUR SYSTEM EFFECTIVENESS.*

(2) *MINIMIZE OUR VULNERABILITIES.*

Section II. GENERAL

1-2. Purpose

The purpose of this manual is to introduce new Field Artillery doctrine for providing responsive, effective fires in support of the maneuver arms on the modern battlefield. This manual is intended to be used only as a guide; therefore, modification may be made based on the knowledge of the gunnery supervisor and the state of training of unit personnel.

1-3. Scope

a. This manual encompasses all aspects of field artillery cannon gunnery. The material presented herein is applicable to both nuclear and nonnuclear warfare.

b. The term "Field Artillery" as used within this manual applies to cannon artillery only.

c. Observer procedures discussed in this manual pertain solely to visual observation.

d. *THIS MANUAL SHOULD BE USED IN CONJUNCTION WITH FM 6-40. ANY CONFLICTS WITH FM 6-40 ARE TO BE RESOLVED IN FAVOR OF THIS MANUAL.*

1-4. Changes or Corrections

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and lines of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded to Commandant, US Army Field Artillery School, ATTN: ATSF-TD-TM, Fort Sill, Oklahoma 73503.

1-5. References

See appendix A for list of references.



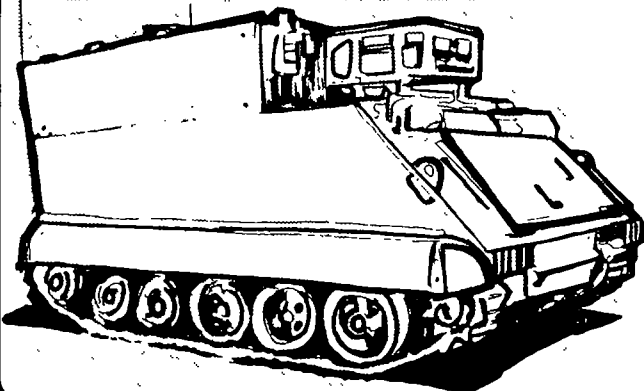
PART TWO

HOW TO ACCOMPLISH THE MISSION



CHAPTER 2

OPTIMIZE SYSTEM EFFECTIVENESS



**HOW TO IMPROVE
RESPONSIVENESS AND
EFFECT ON THE
TARGET**

CHAPTER 2
OPTIMIZE SYSTEM EFFECTIVENESS

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2-1. Threat to Maneuver Forces

a. The enemy will field a large, well-trained, hard-hitting combined arms team equipped with the most modern weapons. His tanks and motorized units will attack our maneuver forces with direct fire and assault fire. His artillery and air defense units will provide extensive support in offensive and defensive operations. His tactical aircraft may strike targets throughout the battlefield. He will use electronic warfare equipment to locate, jam, and deceive our communications and radar systems. He may use chemical weapons, since his forces are well trained in chemical warfare. He may use saboteurs or special action forces in our rear areas.

b. To counter the threat to our maneuver forces, field artillery must be able to neutralize these enemy capabilities at the critical time and place on the battlefield.

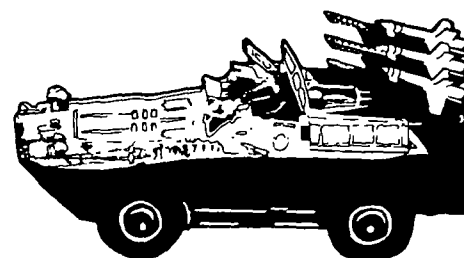
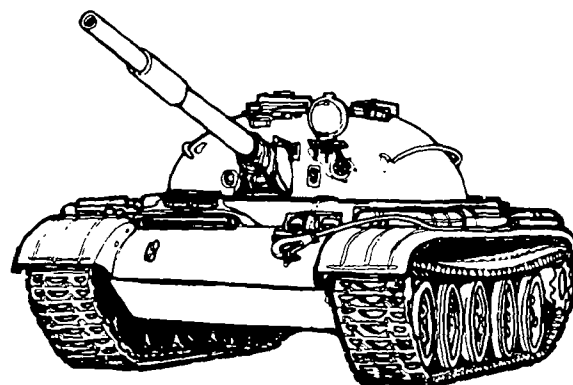
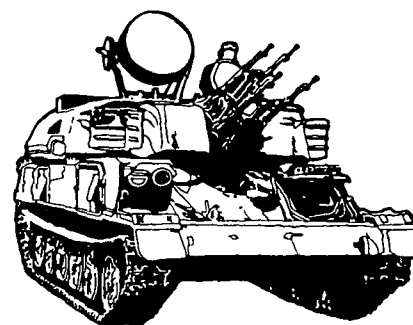
2-2. System Responsiveness

To be an effective force on the modern battlefield, field artillery must be *RESPONSIVE*. We cannot afford the luxury of trying for pinpoint accuracy on every target. If we do not strike quickly, the target may move or may inflict damage on our forces before our rounds impact. We must streamline our procedures in order to minimize the time between target acquisition and rounds bursting on target. Responsiveness can be achieved if we:

- a. Plan ahead.
- b. Streamline the call for fire.
- c. Conduct technical fire direction at the battery level.
- d. Adopt SOP's which streamline fire orders and fire commands.
- e. Compute initial data by the fastest means available (manual, rather than FADAC, normally).
- f. Streamline firing battery procedures (see FM 6-50).

2-3. Effect on the Target

a. *General.* In order to have an effective field artillery system, we must get "the most bang for the buck." We must choose how we

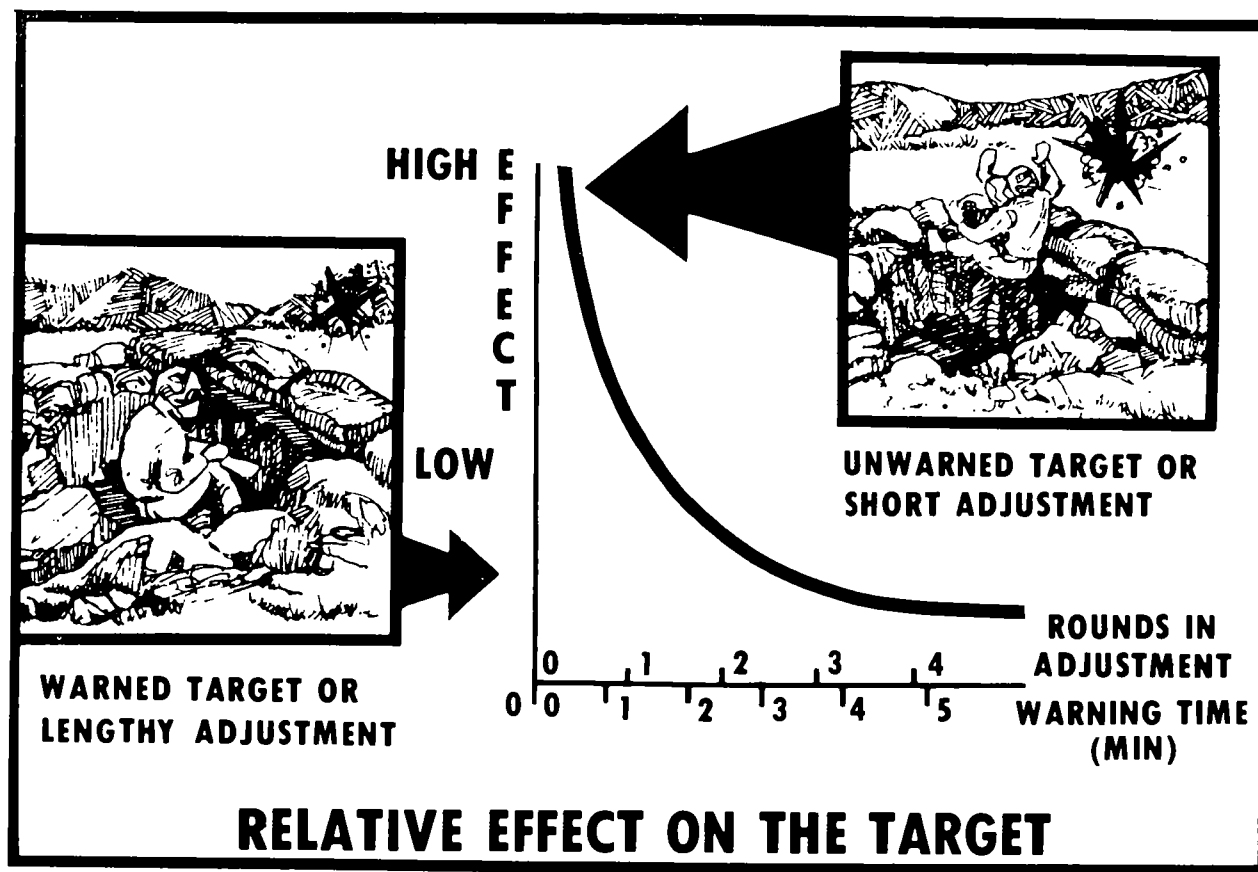


attack and with what we attack to inflict the most damage we can for each round fired.

b. *Strive for surprise.* Accurate surprise fire inflicts the greatest number of casualties. We must *STRIVE FOR FIRST ROUND FIRE FOR EFFECT*, or try for one-round adjustment.

c. *Mass fires.*

(1) The greatest effect on the enemy can be achieved by delivering a large number of rounds from many weapons in the shortest



possible time. Successive volleys give the enemy time to react and seek greater cover.

(2) When multiple firing units are involved, TOT's are generally more effective than "At My Command" and "When Ready" fire missions. The lag between the impact of the first firing unit's volley and the volleys of other firing units will allow the enemy to take protective measures. TOT procedures must be streamlined to minimize the time required to deliver massed fires (see para 9-14).

(3) Massed fires are most important when engaging relatively "soft" (e.g., personnel in open) targets which can quickly become "hard" (e.g., personnel with overhead cover). Figure 2-1 compares the total number

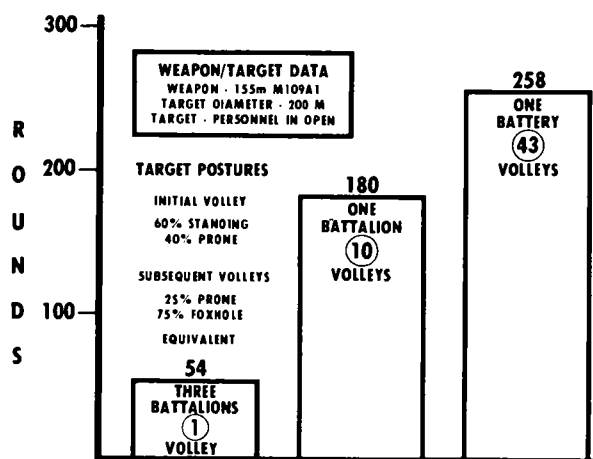
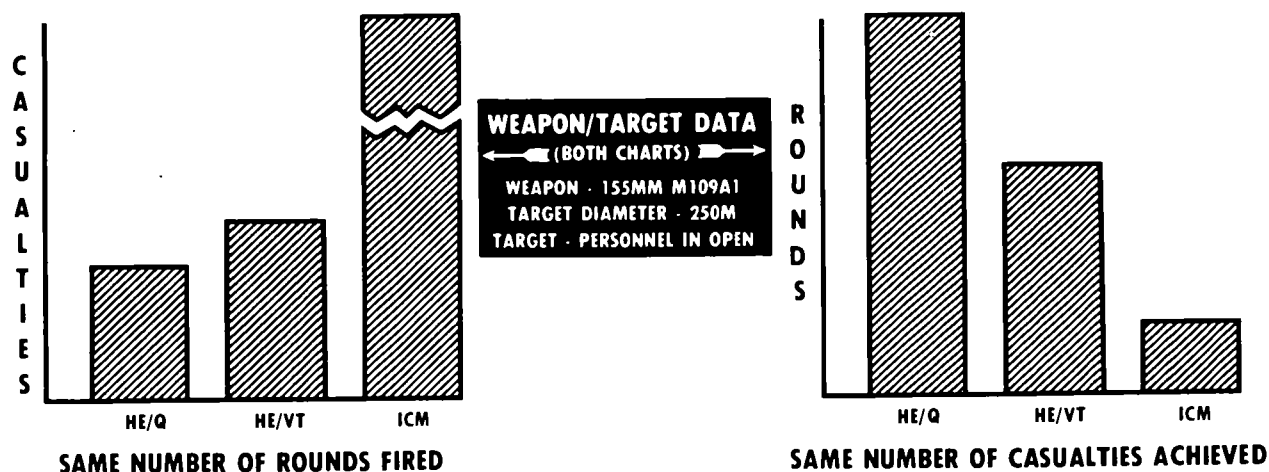


Figure 2-1. Number of rounds to get equivalent effect.



(THESE GRAPHS FOR COMPARISON ONLY)

of rounds which must be fired by a single battalion or a single battery to achieve the same effect as a one-volley, three-battalion TOT (54 rounds).

(4) Mass fires do not give us increased effectiveness for targets that are hard and stay hard. When this is the case, you should strive to get rounds on the target "When Ready" since volume of fire is more important than the method of fire.

d. Munition selection/volume.

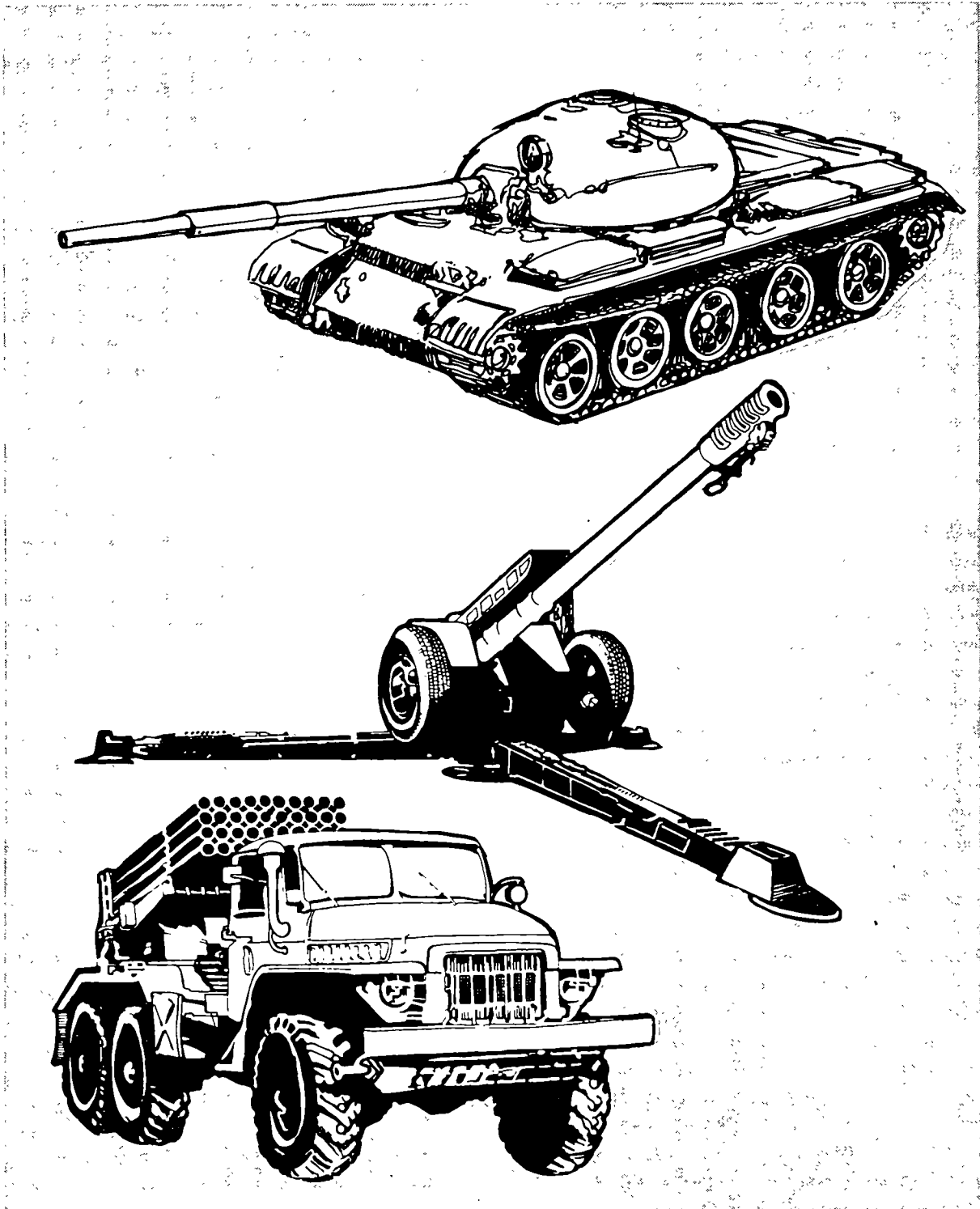
(1) The field artillery will not be able to attack all targets on the battlefield. When a target warrants attack, select the best shell/fuze combination to achieve the desired result. It takes a larger amount of ammuni-

tion to get a given level of effect on the target if the wrong ammunition is used.

(2) Logistical constraints such as basic loads, resupply problems, and ASR's influence the amount and type of ammunition to be employed when attacking a target. If a low priority target is attacked for destruction now, ammunition may not be available later to engage a higher priority target. This ammunition problem is further complicated if we don't attack the "softest" or most vulnerable part of the target; e.g., gun crews versus the guns. The use of massed, flexible firepower to make up for adverse force ratios is possible only if all weapons are able to "pour it on" at the critical time.



CHAPTER 3 MINIMIZE VULNERABILITY



HOW TO SURVIVE ON THE MODERN BATTLEFIELD

CHAPTER 3

MINIMIZE VULNERABILITY

Section I. THREAT TO FIELD ARTILLERY

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Section I. THREAT TO FIELD ARTILLERY

3-1. The Threat

For the first time since World War II, the US Army faces a massive enemy capability in both detection and counterfire. The enemy:

a. Can locate you with these means. . .

ASSET*	CAPABILITY	VULNERABILITY/WEAKNESS**
Ground reconnaissance	Conducts extensively	Camouflage and concealment.
Radio Intercept	Monitors radio conversations.	Good communications security will reduce effectiveness.
Radio Direction Finder	Provides general locations.	Limited to radio line-of-sight.
Radar Direction Finder	Locates radars accurately.	Limited to radio line-of-sight.
Sound Ranging Set	Locates sound sources at ranges up to 15 KM.	High intensity of fire; high winds.
Flash Bases	Sees weapon flash and records the flash-to-bang time.	Limited by line-of-sight and deception.
Countermortar/battery Radar	Locates firing elements at ranges up to 15 KM.	Electronic countermeasures; second round only.
Ground Surveillance Radar	Locates moving targets (equivalent to TPS 25-A).	Line-of-sight; electronic countermeasures.
Photography	Locates units accurately.	Camouflage, concealment, and deception; also may not be timely.
Map Reconnaissance	Locates likely artillery firing positions.	Changes in terrain since the map was made; selection of unlikely firing positions.

* It is unlikely that all the above assets will be employed against you at one time.

** The enemy target acquisition system as a whole will be degraded during highly mobile operations.

b. Can kill you with these indirect fire weapons. . .

WEAPON	RANGE	NORMAL DISTANCE BEHIND FEBA (KM)		RATE OF FIRE (RD/MIN)
		OFFENSE	DEFENSE	
120 mm mortar	5,700 meters	0.5	1	15
240 mm mortar	9,700 meters	2	3	1
130 mm field gun	27,000 meters	5	9	5-6
180 mm field gun	30,000 meters	7	9	1
122 mm howitzer	15,300 meters	3	4	6-8
152 mm howitzer	12,400 meters	3	4	3-4
152 mm gun/howitzer	17,300 meters (est)	4	5	5
122 mm MRL BM-21	20,500 meters	5	5	40 rd/10 min (Rate/reload Time)
122 mm MRL RM-70	20,500 meters	5	5	40 rd/5 min (Rate/reload Time)
Frog 7	11 to 70 kilometers	18	23	1 rd/20 min

Note: All guns and howitzers are towed. Only two self-propelled weapons, probably of 122 mm and 152 mm caliber, are being added to the threat arsenal.

Each motorized rifle battalion has an organic battery of 120mm mortars, and each motorized rifle regiment has an organic battery of 122mm howitzers. Other artillery (artillery regiment and artillery from the Army and Front) is organized into regimental artillery groups (RAG) and divisional artillery groups (DAG). A RAG normally includes two to four artillery battalions (122mm/152mm howitzers) with three firing batteries in each battalion. The DAG also has two to four artillery battalions (122mm/130mm/152mm guns or howitzers and a 122mm multiple rocket

launcher battalion).

c. *Will use these counterbattery tactics. . .*

The enemy plans to fire an enormous number of rounds during his counterfires. To neutralize your unit, one, two, or three batteries may fire the number of rounds shown in the table below. In some cases the battery may not be accurately located by the enemy. Therefore, the actual number of rounds that impact in the battery area may be less than shown in the table.

TARGET UNIT	GT RANGE		
	8 KM	12 KM	16 KM
SP/ARMORED BTRY (M109A1)	290-330 Rds	550-650 Rds	900 Rds
SP/NONARMORED BTRY (M107/M110)	260-280 Rds	430-540 Rds	750-790 Rds
TOWED BTRY (M102/M114A1)	170-210 Rds	280-330 Rds	450-490 Rds

Section II. MINIMIZE VULNERABILITY

3-2. Command/Control

The field artillery must be able to shoot to accomplish its mission. But to shoot at all targets that appear or to register as frequently as we have in the past may invite disaster. We must *SHOOT LESS OFTEN and MORE DECEPTIVELY* in order to survive. Command guidance establishes rules for the attack of targets, registrations, and positioning. Certain units may fire from roving positions while other units remain silent in hardened positions in order to save some artillery for the critical time.

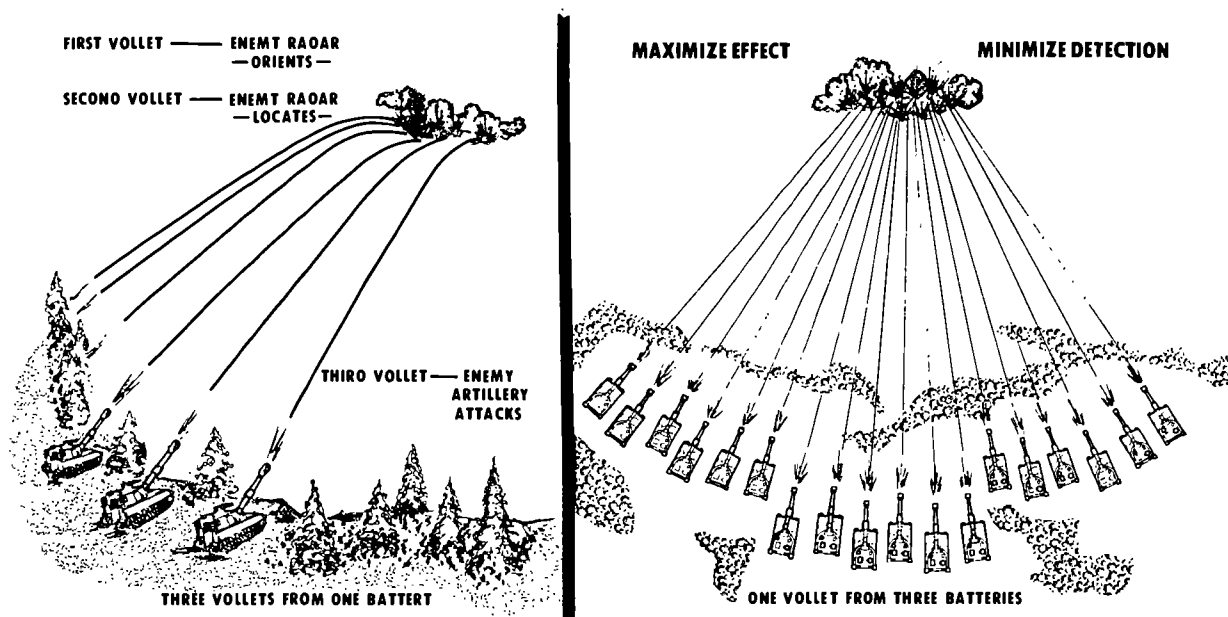
3-3. Avoid Detection

a. *General.* With the vast number of detection devices and systems the enemy will employ, the likelihood he will detect a unit firing is high. Therefore, we must use methods to *AVOID DETECTION and DECEIVE OR CONFUSE THE ENEMY* as to where the bulk of our artillery is located.

b. *Strive for surprise fire.* Surprise fire will reduce the vulnerability of the firing unit. If adjustment is necessary, a bold shift into fire for effect is the next best alternative to surprise fire.

c. *Fire massed fires.* The enemy's ability to quickly locate and return large volumes of fire against our batteries can be reduced by using mass fire techniques. Many volleys from one position allow the enemy to orient himself, locate your position, and attack you. Massed fires reduce the vulnerability of each battery by flooding enemy radar and sound systems for a very short period of time. This confuses the system operator and reduces the possibility that he will accurately locate even one of the firing units.

d. *Fire under the radar screen.* Firing the highest practical charge will lower the trajectory and decrease the time of flight. Rather than passing through the radar beams, the



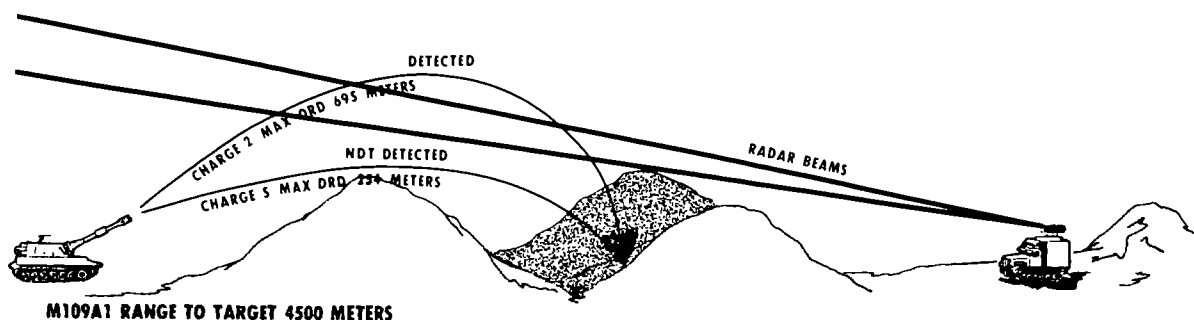
Firing Massed Fires.

projectile will pass below the beams. The responsiveness, improved delivery accuracy, and survivability (against radar) of a high charge, however, must be weighed against the better effects, reduced wear and tear on the howitzer, and reduced vulnerability (to flash and sound ranging) of a low charge. Intervening crests may also require the use of a lower charge. The FDO must determine the most *PRACTICAL* charge to fire.

e. *Limit registrations.* From a vulnerability viewpoint, the best option is to fire MET + VE data whenever possible. Depending on the situation and the degree of accuracy needed, a number of methods are available to obtain corrections needed for predicted fires.

(1) Offset registration. Supplementary positions may be used to fire registrations. Survey requirements are the same for the offset positions as for the primary position. Connection survey should be used to tie in the position when time permits. Otherwise, prominent terrain features can be occupied to minimize errors in map spotting. *DIRECTIONAL CONTROL* (i.e., survey or simultaneous observation) *IS REQUIRED TO TRANSFER A DEFLECTION CORRECTION*. Offset registrations conducted simultaneously with firings from other locations will decrease vulnerability to enemy target acquisition and disguise the registration.

(2) Abbreviated precision registration. A



Using Higher Charge to Fire Under Radar Screen.

precision registration is abbreviated by the observer terminating the registration when he is reasonably certain that he can make a correction which will move the next round (if fired) to the registration point.

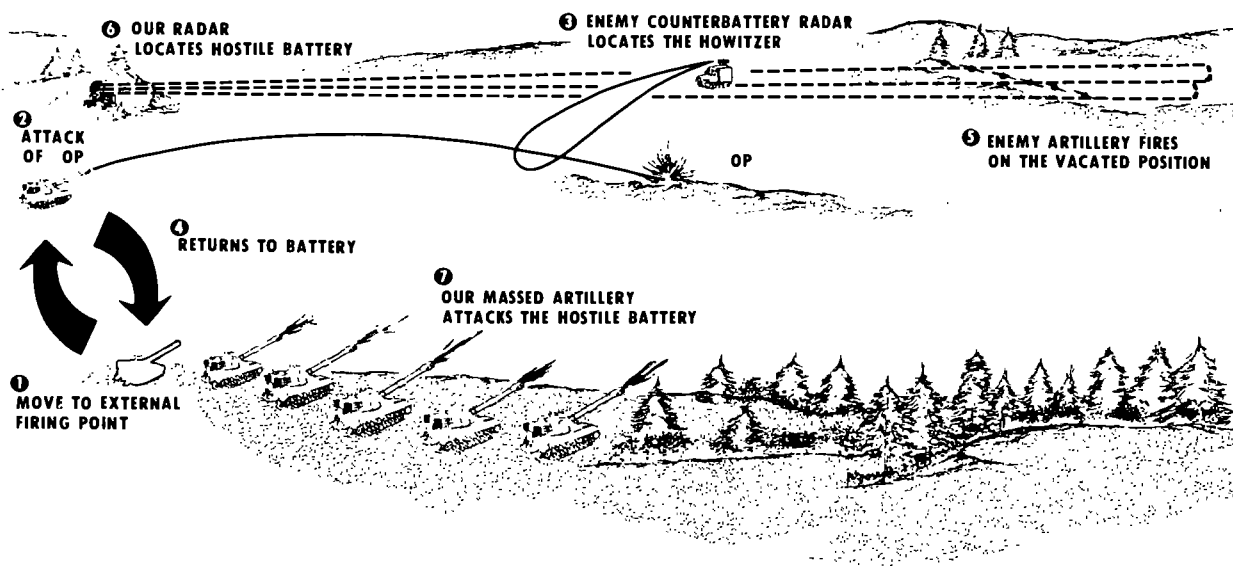
(3) Abbreviated high-burst or mean-point-of-impact registration. An abbreviated HB or MPI registration can provide the battery with valid firing corrections. Except for firing a smaller number of rounds, the procedures for firing and computing registration corrections are the same for the abbreviated registration as for the normal six-round registration.

(4) Registration to the rear. Registering in the opposite direction from the enemy, if possible, will reduce both the vulnerability to detection by enemy target acquisition and, if the firing is detected, the accuracy of the target location. The registration conducted should normally be an abbreviated HB, MPI, or precision registration.

(5) Complete registration. Complete registrations provide the highest degree of accuracy for registration corrections but also provide the enemy with the ideal conditions for target acquisition.

DATA FROM A NORMAL AREA FIRE MISSION MAY PROVIDE REGISTRATION CORRECTIONS, PROVIDED THE TARGET IS ACCURATELY LOCATED AND THE OBSERVER HAS GIVEN NECESSARY REFINEMENT CORRECTIONS FOLLOWING FIRE FOR EFFECT.

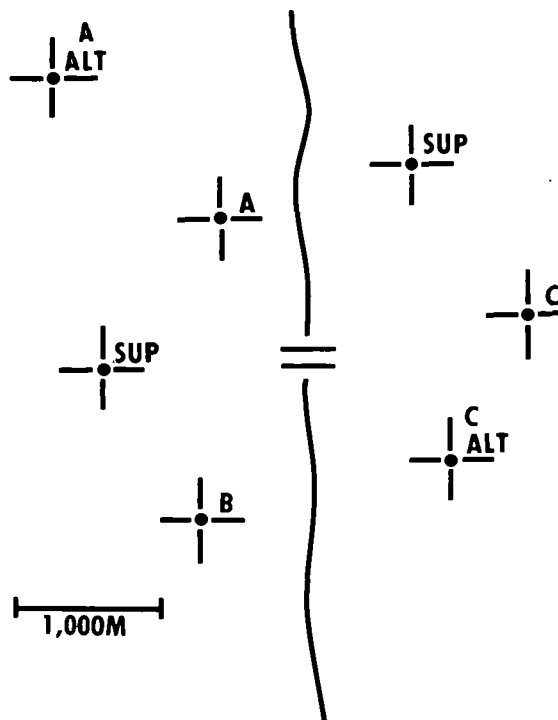
f. Roving gun or battery. The roving gun may be used to conduct registrations and fire missions from a number of supplementary positions and thereby assist in both concealing the battery's primary firing position and confusing the enemy as to the number of fire units we are employing. Deceptive firing positions will be vacated upon completion of a specific mission; therefore, they can be locations easy to identify on a map. Survey requirements will be minimized, but the capability for massing fires is not degraded. However, any errors in location or direction will affect the fire-for-effect accuracy of the non-adjusting elements. If resources are available, a roving battery may be used to further confuse the enemy. As a general rule, the roving battery should be from a reinforcing battalion.



Using the Roving Gun to Deceive the Enemy.

3-4. Separation of Positions

Batteries should be positioned to support subelements of the maneuver brigade, rather than be grouped in a battalion position area. Primary and alternate positions should be separated by at least 1000 meters so that the effect of counterfire on one position will not endanger other positions. Separation will vary according to the terrain and the enemy threat.





PART THREE

OBSERVED FIRE

CHAPTER 4

FORWARD OBSERVER



**HOW THE FORWARD OBSERVER CAN IMPROVE
RESPONSIVENESS, FLEXIBILITY, AND SURVIVABILITY**

CHAPTER 4

FORWARD OBSERVER

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Section I. INTRODUCTION

4-1. General

The forward observer (FO) plays a key role in providing responsive fire support to the maneuver unit. This is because he is the member of the gunnery team in a position to locate and adjust fire on the enemy. Today, more than ever before, the forward observer must be well trained in more than just the adjustment of artillery fire. He must keep abreast of both friendly and enemy situations. He must constantly anticipate needs of the maneuver forces. The FO provides the

maneuver unit commander with technical advice on the employment of all fire support means.

4-2. The Eyes of the Field Artillery

The FO is the "eyes" of the field artillery. He is a *VITAL* source of intelligence for the artillery. He must provide timely information through battlefield surveillance to the battalion S2. The FO's reporting must be *TIMELY* and *ACCURATE* to defeat the enemy before the enemy can defeat him.

Section II. PREPARATORY OPERATIONS

4-3. General

Even before an operation begins, you must prepare yourself and your team for the operation. To provide responsive support, you must keep four tactical considerations in mind. They are:

a. Know the terrain. An analysis of FO training has demonstrated that:

BETTER KNOWLEDGE OF THE TERRAIN = A MORE RESPONSIVE AND ACCURATE FO.

Familiarity with the terrain may be as little as a map inspection prior to an operation or as much as physically reconning the area. In any case, you must try to associate as much of the land as you can with what is depicted on your map. Whenever possible, accompany the supported commander when he reconnoiters the area in which the company will operate.

b. Anticipate maneuver requirements. Based on your analysis of the terrain and the scheme of maneuver, plan targets to give the maneuver unit freedom of action in anticipated encounters with the enemy. Identify and assign target numbers to those areas that would present the greatest threat if they were occupied by the enemy. Only targets essential to the accomplishment of the mission need be planned.

c. Be in a position to observe. Once the operation begins, continue to keep yourself in a position to observe the action. The higher you can place yourself overlooking the target (but not disregarding concealment), the better you will be able to adjust fire and perform your other duties as an observer.

d. Be flexible. You must be ready to make changes to your plans in order to provide continuous, responsive fire support. Should an action by you not be adequate, you should have alternate plans and means available to get the job done.

4-4. Map-Terrain Association

You should constantly make a thorough analysis of the terrain and map for your area of operation.

a. Some techniques to be used are:

(1) Locate yourself accurately. You should be able to determine a six-place grid of your location at all times.

(2) Locate all registration points, targets, and likely points of enemy activity. Use of prominent terrain features will help relate a potential target area to a grid location on a map. If time is available, the observed fire (OF) fan can be a helpful aid in determining locations in the target area.

(3) Make a thorough study of terrain. You should:

(a) Inspect the ground, paying close attention to detail.

(b) Look for different colors of grass which might reveal hills and valleys.

(c) Find all roads in the area because they are easily associated with terrain features on the map.

(d) Locate streams and other bodies of water because they are easily found on the map.

(e) Locate manmade objects such as buildings, dams, or trig markers that can be seen on both the terrain and the map.

(f) Be extremely familiar with the terrain when in a defensive posture. One advantage of defense is that you are more familiar with the terrain than the enemy is. Make the most of this advantage; study the terrain to your flanks and rear as well as to your front. Also, remember that -

TODAY'S DEFENSIVE POSITION
MAY BE TOMORROW'S TARGET
AREA.

(4) Conduct surveillance of areas previously fired on. Once a fire mission is completed you should analyze the terrain in the vicinity of the target. Look for places where the enemy might hide personnel or conceal equipment.

(5) Conduct constant surveillance of critical areas, such as avenues of approach and probable assembly areas. Monitor these areas constantly so that targets that appear can be neutralized or suppressed immediately.

(6) Whenever possible, make a terrain sketch of the area. This will help associate the terrain with your map.

b. A thorough map and terrain analysis is the key to the accurate location of targets.

AN FO CAN NEVER BE TOO FAMILIAR WITH THE TERRAIN.

4-5. Mobile Operations

a. The battlefield of the future will present a highly mobile and rapidly changing environment, characterized by mechanized forces and violent action. As a forward observer assigned to support a mechanized force, you will suddenly find yourself thrust into a fast-action situation demanding thorough training, detailed preparation, and absolute professionalism. Because target location is the most significant factor in achieving quick and effective results, it is important to realize that your success may very well depend on your experience in map reading and terrain association. Therefore, any forward observer training program should be composed primarily of instruction in mobile operations.

b. Mechanized forces are apt to move over wide expanses of terrain in a short period of time in execution of their mission. Your success in staying abreast of the situation, providing the proper fire support, and surviving will, in large part, depend on your preparations *before* the operation commences.

(1) Armored operations.

(a) When operating in support of an armored company, you may be mounted in a tank; thus in addition to your requirements as an FO, you may be the commander of a major combat vehicle, which you must use to move about on the battlefield. Become acquainted with this vehicle before the operation. Learn its capabilities and limitations, where you can and cannot maneuver the vehicle, and how the on-board equipment operates, especially the communications system which you yourself will have to operate.

(b) The tank is equipped with a VRC-12 radio which permits you to transmit or receive on your primary FD net and to monitor the maneuver company net. The VRC-12 has the capability for 10 preset frequencies, which you can quickly change from your position in the commander's hatch of the tank. Before departing on an operation, obtain all the frequencies to be used by the maneuver unit. These frequencies, as well as your own artillery frequencies, can then be preset to allow quick,

flexible communications.

(c) When conducting missions from a tank, you will act as your own radio telephone operator (RTO). You will wear a helmet designed for transmitting or receiving on the FM radio and for communication on the vehicle intercom system. Be thoroughly trained in radio procedures and the call for fire to insure the smooth, uninterrupted flow of communications.

(2) Mechanized infantry operations. If you are supporting a mechanized infantry force, you will be equipped with an M151A1 1/4-ton vehicle and will have the normal equipment and personnel organic to an FO team. You will, however, normally ride in a tracked vehicle with the company commander. Your reconnaissance sergeant and the radio telephone operator may either accompany you or ride with one of the platoon commanders. When you are with the maneuver elements in a command track, you do not have priority in using and positioning the vehicle; therefore, be prepared to dismount and move to a position to accomplish your mission. You must use your own PRC-77 for communications when riding in an APC.

(3) Map and terrain orientation. One of the most difficult tasks will be to keep yourself oriented on the terrain so that you can quickly and accurately plan and call for fires. There is no simple solution for FO orientation. It demands an automatic, ingrained, continuous concentration on knowing one's current location.

(4) Scheme of maneuver. Be thoroughly aware of the commander's plan of operation and be able to advise him on the proper use of his fire support means.

c. The difficulty in locating targets and adjusting fires increases as the situation becomes more fluid.

(1) Direction. Even the very simple task of determining an observer-target (OT) direction is complicated in a mechanized operation; the OT direction is constantly changing. Depending on the tactical situation, you can use one of several means of determining the direction. You can--

(a) Measure with a compass. Be extremely careful when using a compass on or near a tracked vehicle. A lensatic compass will provide sufficiently accurate directions when used on an APC if the radio is not keyed and if the compass is not in close proximity to the engine compartment. The lensatic compass is *not* satisfactory, however, when used in a tank. The M2 compass will produce erratic and unsatisfactory results when used near any tracked vehicle. If the tactical situation permits, dismount and move 40-50 meters from the vehicle to sufficiently avoid magnetic interference.

(b) Measure (estimate) from a map. If you have been able to keep yourself located, measure (estimate) the OT direction from the map.

(c) Estimate. It may be necessary to estimate the OT direction solely from your knowledge of the area of operations. Send the estimated direction in mils, degrees, or as one of the eight cardinal directions (N, NE, E, SE, S, SW, W, NW).

(d) Use the gun-target (GT) line. The GT line may be used for the adjustment of fire. You can have the GT line identified on the ground by requesting ranging rounds. Ranging rounds can also assist you in estimating direction if you become disoriented. If you know the azimuth of the GT line, by visualizing the relation of your OT line to the GT line and estimating the angular deviation, you can derive your OT direction.

(e) Regardless of the method used to determine the initial direction, you will frequently find it necessary to send a new OT direction to the FDC. This change in OT direction may be caused by your movement, movement of the target, or because of excessive error in the initial direction (which will be evident in subsequent corrections). The major point is to be constantly aware of the changing direction and take action to correct an error as soon as you detect it.

(2) Target location.

(a) The polar plot method is somewhat limited for use in a highly mobile

situation. The most critical requirement of this method is for the FDC to know your location. In a fast-moving situation, your position will be changing so quickly that it is doubtful that the FDC will have it plotted on their charts or in FADAC. If you are stationary for a period of time, encode your location and transmit it to the FDC so that you will have the option to polar plot targets.

(b) If you make a detailed map and terrain analysis as you enter new areas, locating targets by grid will probably be the fastest and most accurate method. This is especially true if you have carefully followed your movements on the map and have analyzed the terrain to identify major features and possible locations for enemy forces.

(c) If you have planned targets and reported these planned targets (and the maneuver checkpoints) to the FDC, you can effectively shift onto targets of opportunity. The accuracy of the shift will be largely dependent on the accuracy of the OT direction.

(d) Should you become disoriented during movement and need to engage a target that cannot be located immediately, call for a round on a planned target and shift from the burst location. If you become so disoriented that you cannot locate a target by any of the methods, call for *MARK CENTER OF SECTOR*. In both of these instances, the FDC must have a thorough knowledge of the tactical situation and the disposition of friendly forces to preclude firing on the maneuver unit. If there is doubt about the safety of the firing, a high airburst (e.g., 200 meters) with shell HE or WP can be used to provide orientation. (The tactical soundness of the high airburst must be

considered.) No matter how disoriented you become, you can place a round in the target area, which becomes a common or known point between yourself and the FDC. Imagination and aggressiveness are essential; you should never reach the point at which you are so disoriented that you cannot shoot in support of the maneuver unit.

(3) FO location. Your location during the conduct of a mission will be dictated by the tactical situation. It may be stationary such as in an overwatch position providing fires for a bounding element. If you are on the move during the conduct of a mission, the location of targets and adjustment of fires are very difficult, but far from impossible. Keep in mind the constantly changing OT direction, make bold adjustments, and move the bursts to the target using normal adjustment procedures. You may be able to stop between rounds to improve the accuracy of your subsequent corrections, but strive to remain abreast of the maneuver unit.

d. Support of the mechanized force is a challenging mission, one which is complicated by the fast moving situation. Perhaps the single, most vital consideration for you to remember in a mobile situation is the absolute requirement for a detailed map and terrain analysis before the operation commences. Extending into the operation itself, carefully follow your movement on the map so that you are constantly aware of your location in relation to major terrain features, planned targets, and maneuver control measures. Finally, no matter how extensive the training and preparation-

THERE IS NO SUBSTITUTE FOR AGGRESSIVENESS AND SOUND JUDGMENT.
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Section III. GENERAL TECHNIQUES

4-6. Responsiveness

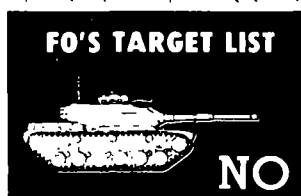
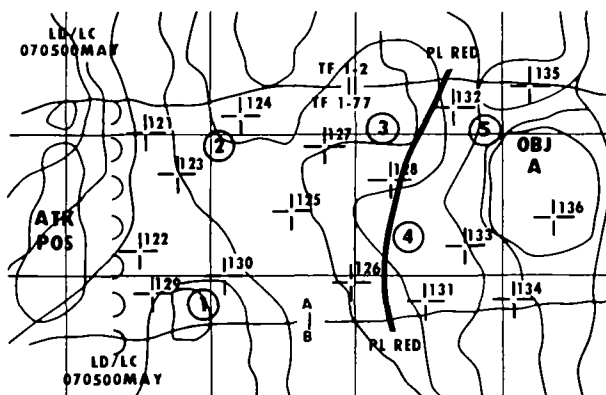
a. *General.* Always seek to employ techniques that will improve your responsiveness, flexibility, and survivability. If you can

short-cut a procedure to get data more efficiently to the FSO or FDC, you should do so. On the modern battlefield time is critical and it is up to you to make timely decisions to counter the enemy threat.

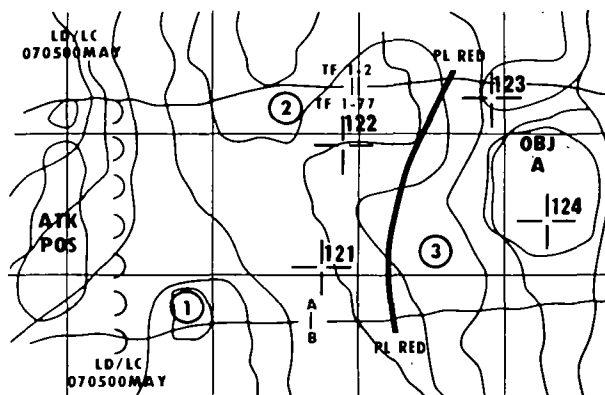
b. Fire planning. Fire planning will be continuous. The targets planned should only be those which are essential to the accomplishment of the maneuver unit's mission. Too many planned targets may result in confusion and lessened responsiveness.

c. Transmitting the target list. All planned targets will be sent using the most expeditious secure means available.

(1) You can send lists of encoded target locations using the KAL 61:



Too Many Targets.



Only Essential Targets.

H18 THIS IS H24, TARGET LIST FOLLOWS, OVER.

121, GRID I SET HS, NTBIEV, ICM, OVER.

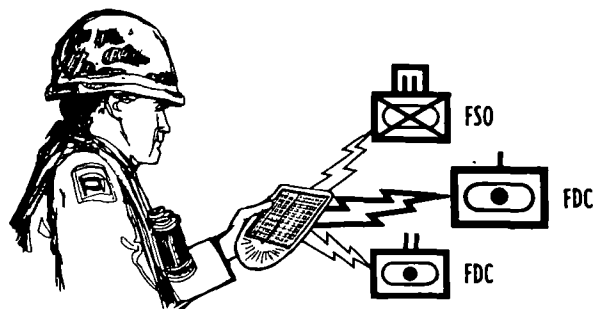
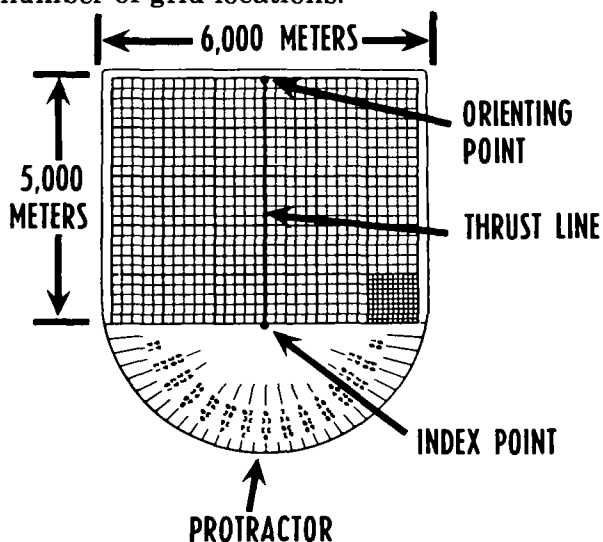
122, FROM 121, DIRECTION 0160, ADD 850, SUPPRESSION, HE/VT AND SMOKE, OVER.

123, FROM 121, DIRECTION NORTHEAST, ADD 1500, PRIORITY, OVER.

124, FROM 121, DIRECTION 1380, ADD 1400, SUPPRESSION, HE/VT, END OF TARGET, LIST, OVER.

(2) You can submit hasty target lists to the FSO by using the **GRIDDED THRUST LINE**.

(a) The **GRIDDED THRUST LINE** is a method of rapidly passing targeting data and maneuver control measures (checkpoints and phase lines), when speed is essential and limited security is acceptable. Its only advantage is to speed encoding and decoding a number of grid locations.



(b) The basic tool is the clear plastic, pocket-size, gridded template shown at the left (scale 1:50,000). The index and orienting points are fixed in relation to the template as shown. The FSO and FDC can use target grids to plot targets sent this way.

(c) Labelling the gridded template.

■ To label the grid lines on the template, refer to the gridded template coding table (see table 4-1) in your CEOI (Division C-E officers can prepare the table IAW AR 380-52) and select two letters. The first is randomly chosen from the left column and the second is chosen from the line which follows the first. For example, selecting

Table 4-1. CEOI extract portion of gridded template coding table.

		Ø 1 2 3 4 5 6 7 8 9									
A	T W K Q Z E	F H X G I	*	*	*	*	*	*	*	*	*
B	W X A I H Z	E B Y C F	*	*	*	*	*	*	*	*	*
C	I O P Q U K	M A N B E	*	*	*	*	*	*	*	*	*
D	* * * * *	* * * * *	*	*	*	*	*	*	*	*	*
E	* * * * *	* * * * *	*	*	*	*	*	*	*	*	*
:											
:											
:											
W	* * * * *	* * * * *	*	*	*	*	*	*	*	*	*
X	* * * * *	* * * * *	*	*	*	*	*	*	*	*	*
Y	J I F E A K	O B Q N P	C	H	L	R	T	D	M	G	W S
Z	K P M Q O S	R V D T Z	A	G	N	U	C	H	J	B	L F

letters *B* and *H*, enter the table at line *B*, read across to letter *H*, and extract the letter *Z* just to the right of it.

■ Reenter the table on line *Z* and write the first 6 letters (*KPMQOS*) across the bottom of the template from left to right and the next five letters (*RVDTZ*) on the right side of the template from bottom to top. On the frosted white rectangle (in the middle of the protractor portion of the gridded template), write the numbers 0 *THROUGH* 9 and the letters to be used for encoding the numbers (see fig 4-1). This completes labelling the template to the right and up, the same way it will be read. This coding may be given to the FDC merely by sending:

TEMPLATE CODE BRAVO HOTEL,
OVER.

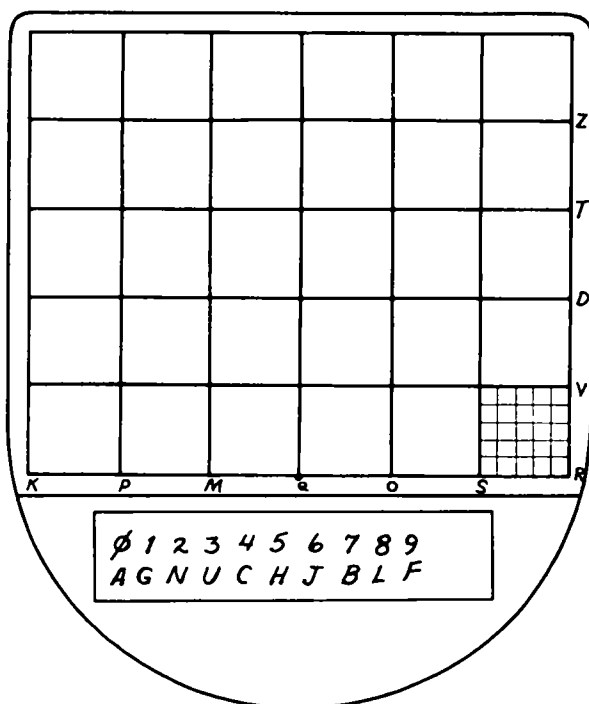
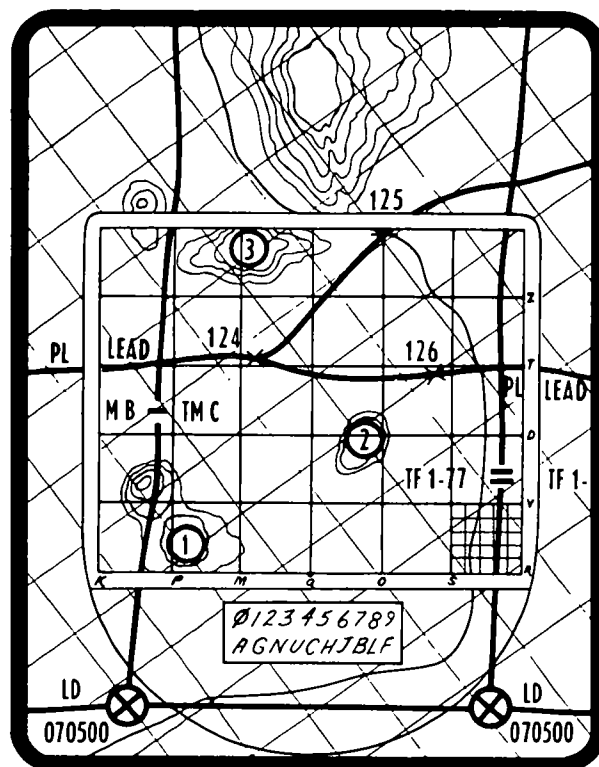


Figure 4-1. Encoded gridded template.

■ When the FDC needs to know if the proper CEOI item has been used or the source is legitimate, authentication can be requested. Authenticate by sending the letter



below the second letter that was sent to encode the template. In the example above, the authentication of *BH* is *U*.

(d) Place the coded template over the planned targets on your map, mark the index and orienting points, and draw the thrust line. The KAL 61 is used to encode the coordinates for the index point or an azimuth from the index to the orienting point. This information is sent to the FSO as follows:

B57 THIS IS B52, TEMPLATE CODE
BRAVO HOTEL, OVER.

(from CEOI gridded template coding table).

GRID I SET AL, → AXGWTF,
FCOTLP (or AZIMUTH FAGW),
OVER.

Index point (coded with KAL 61). Orienting point or thrust line azimuth (encoded with KAL 61)

(e) To send checkpoint/target locations, read *RIGHT* and *UP*. In the example below, target 124 is located in block MT and is

200 meters to the right of line M and 100M above line T. A sample transmission follows:

THIS IS B52, TARGET LIST
FOLLOWS, OVER.

CP 1 IS PNRC, OVER.

CP 2 IS QLVF, PRIORITY, OVER.

CP 3 IS MGZB, OVER.

TGT 124 IS MNTG, PRIORITY, OVER.

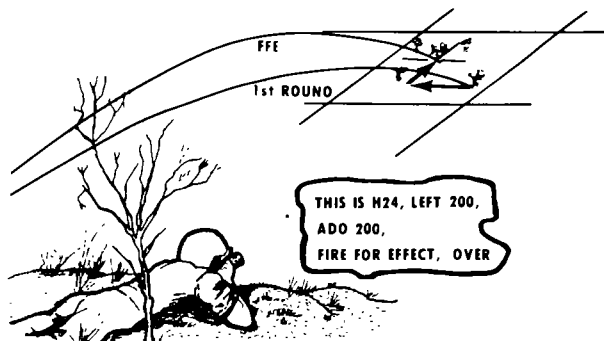
TGT 125 IS OAZL, SMOKE, OVER.

TGT 126 IS OBDF, ATTITUDE 1900,
LENGTH 300, END OF TARGET
LIST, OVER.

d. Call for fire. The call for fire has been changed somewhat from what is shown in FM 6-40. See Chapter 5 for a detailed discussion of the call for fire.

e. Minor deviation corrections. Deviation corrections of 20 meters or less will be ignored during any area fire mission except when providing refinement data.

f. Aggressiveness. **BE BOLD IN THE CONDUCT OF THE ADJUSTMENT PHASE OF AN ADJUST FIRE MISSION**



and use every opportunity to shorten that phase. Make every effort to correct the initial round onto the target and enter fire for effect. Remember, massed surprise fire on an accurately located target gives us our greatest effect. If this is not possible, rapidly establish a hasty bracket (a round over and a round short). Use the distance between the bracketing rounds as a yardstick to determine the correction to enter FFE.

4-7 Flexibility

a. Use of maneuver weapons. Field artillery is not the only firepower available to the Company/Team commander. As the senior fire support representative with the Company/Team, it is your responsibility to advise the maneuver commander as to the appropriate weapon system to use to attack a target. This includes the direct and indirect fire weapons organic to the maneuver arms. You should consider the capabilities, limitations, and responsiveness of those weapons.

b. Call for fire from maneuver element (untrained observer). Whenever possible, calls for fire from maneuver elements should be channeled through an FO. Be prepared to talk the untrained observer through the fire mission.

c. Multiple missions. Contact with the enemy may be so extensive that you must transmit two or more calls for fire and conduct the adjustment of all missions simultaneously. Consult the maneuver commander, if possible, or use your own best judgment to decide which target to engage first. Keep your missions from being confused with other FOs' missions by continuing to use your call sign. Keep your own missions "straight" by calling the missions *MISSION 1* and *MISSION 2*. To avoid errors, write down the corrections for each mission so you can refer to them whenever you need to.

d. 24-hour operation. The FO party recon sergeant and RTO both must be well trained in order to handle calls for fire during your absence.

e. All weather/visibility operation. The enemy will often move at night or in fog, rain, or other weather which reduces your ability

to observe him. Reduce the effect of poor weather/visibility by using:

(1) Battlefield illumination to provide additional light during periods of darkness. Use of illumination must follow the commander's guidance.

(2) Night vision devices which amplify reflected light to improve vision during darkness.

(3) Field artillery and maneuver element radars which can act as the eyes of the FO during periods of limited visibility. The maneuver unit's ground surveillance radar is an immediately available detection means.

(4) Sensors which can be used to locate targets for firing or on which to orient other target acquisition means.

f. FO as own RTO. There may be times when you will have to act as your own RTO. In mechanized operations this will be common because you should be in your own tank or riding in an APC. If the FO party is split so that the recon sergeant and RTO work with one of the maneuver platoons, you will act as your own RTO.

4-8. Minimize Vulnerability

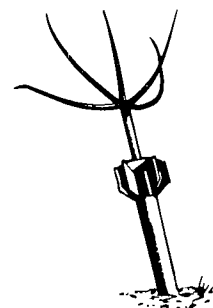
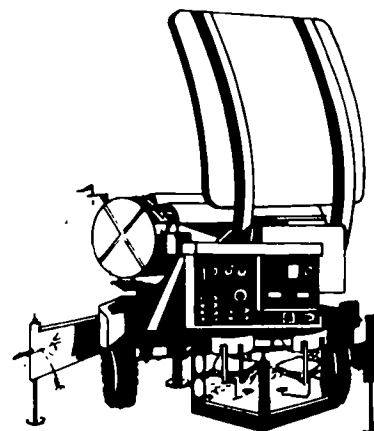
a. In order to accomplish the mission, you must survive. Learn to minimize your vulnerability through the proper use of *COVER*, *CONCEALMENT*, and *CAMOUFLAGE*. Every member of the combined arms team is responsible for the proper application of these techniques. They must be learned and constantly applied to all personnel, equipment, and positions.

(1) *COVER* provides protection from enemy fire.

(2) *CONCEALMENT* provides protection from enemy observation, detection, or recognition.

(3) *CAMOUFLAGE* is any natural or artificial material used to provide concealment.

b. The FM radio link between you and the FDC is the basic communications vulnerability of the field artillery system. Minimize this vulnerability by:



(1) Communicating only when absolutely necessary.

(2) Deferring initial exposure of the F net as long as possible.

(3) Communicating by wire when wire circuits are available.

(4) Sending administrative and planning information by messenger when time and resources permit.

(5) Remoting radios in static situations.

(6) Using an expedient long-wire directional antenna.

(7) Using the supported company commander's secure radio for fire planning.

c. Analyze each target rapidly to determine whether the importance of the target warrants its engagement and the possible detection of the field artillery firing unit.

d. The traditional methods of target location--polar plot, grid, and shift from a known point--make you and the maneuver company vulnerable to being located after the enemy has intercepted only one or two

calls for fire. Minimize this vulnerability by using a gun-target line adjustment technique, by encoding the observer-target direction when speed is not critical, by adding a known (given) value to the actual OT direction, or by frequently changing location.

Note. When constantly moving, the vulnerability incurred by sending the OT direction in the clear is minimal.

CHAPTER 5

CALL FOR FIRE



CHAPTER 5

CALL FOR FIRE

Section I. THE CALL FOR FIRE

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Section I. THE CALL FOR FIRE

5-1. Elements and Sequence of Calls for Fire.

a. A call for fire is a concise message prepared by the observer. It contains all the information needed by the FDC to determine the data and method of target attack. The call for fire must be sent rapidly but with enough clarity that it can be understood, recorded, and read back without error by the FDC RTO. Tell your RTO that you have seen a target. Have the RTO start the call for fire while you are determining the target location. Send information as it is determined rather than wait until you have a complete call for fire.

b. Regardless of the method of target location used, the normal call for fire will be transmitted in a maximum of three parts, with a break and readback after each part. The three parts are:

- (1) Observer identification and warning order.
- (2) All data required to locate the target.
- (3) All remaining elements of the call for fire.

c. A list of elements in the sequence in which they are transmitted is shown in (1) through (6) below. These elements are discussed in paragraphs 5-2 through 5-6.

- (1) Observer identification.
- (2) Warning order.
- (3) Location of target.
- (4) Description of target.
- (5) Method of engagement.
- (6) Method of fire and control.

5-2. Observer Identification and Warning Order

These elements of the call for fire let the FDC know who is calling for fire and clear the net for your fire mission. The warning order element consists of the:

- a. *Type of mission.*

(1) Adjust fire (AF).^{*} When you can see the target, announce *ADJUST FIRE* if you feel that you will have to conduct an adjustment before firing for effect.

(2) Fire for effect (FFE).^{*} You should *ALWAYS* strive for first round FFE. The accuracy required to FFE depends on the target and the ammunition being employed. If you are certain that the announced target location is accurate enough, and the first volley would have effect on the target so that little or no adjustment is required, announce *FIRE FOR EFFECT*.

^{*}Although technically methods of control, AF and FFE have been included in the warning order to increase responsiveness.

(3) Suppress (S). To rapidly bring fire on an on-call target (that is not currently active), announce *SUPPRESS* (followed by the target identification).

(4) Immediate suppression (IS). When engaging a target (a planned target or a target of opportunity) that has taken maneuver elements under fire, announce *IMMEDIATE SUPPRESSION*.

b. *Size of element to fire.* You may request the size of the unit to fire for effect; e.g., *BATTALION*.

c. *Method of target location that will be used.*

(1) Polar plot. If you locate the target using the polar plot method of target location, announce *POLAR*; e.g., *ADJUST FIRE, POLAR*.

(2) Shift from a known point. If you locate the target using the shift-from-a-known-point method of target location, announce *SHIFT* (followed by the known point); e.g., *ADJUST FIRE, SHIFT 166*.

(3) Grid. If neither *POLAR* nor *SHIFT* is announced, you are using the grid method of target location. The word grid is not announced (here) to indicate the method of target location.

d. Examples.

- (1) Adjust fire mission.

GRID:

A57, THIS IS A71, ADJUST FIRE,
OVER.

- (2) Fire for effect mission.

POLAR PLOT:

A57, THIS IS A71, FIRE FOR
EFFECT, BATTALION, POLAR,
OVER.

SHIFT FROM A KNOWN POINT:

A57, THIS IS A71, FIRE FOR
EFFECT, SHIFT 176, OVER.

- (3) Suppress mission.

THIS IS F72, SUPPRESS,
CHECKPOINT 10, OVER.

- (4) Immediate suppression mission.

THIS IS F72, IMMEDIATE
SUPPRESSION, 176, OVER.

5-3. Location of the Target

This element enables the FADAC (chart) operator to input (plot) the location of the target in FADAC (on the chart) in order to determine firing data. To do this, the operator needs one or more of the following pieces of information:

a. Grid mission.

(1) Six-place grids are all that the FDC needs, since this is all the accuracy required in an area mission. Eight-place grids should

be sent for registration points or other points for which greater accuracy is required (as long as this does not slow down an urgent mission).

(2) The OT direction normally will be sent after the call for fire since the FDC does not need it for the first round.

(3) A known point may be used as a quick way of sending the target location; e.g., *ROAD JUNCTION R7* tells the FDC exactly where the target is.

b. Shift-from-a-known-point mission. The point from which you will make your shift will be sent in the method of target location. To finish locating the target the FDC needs:

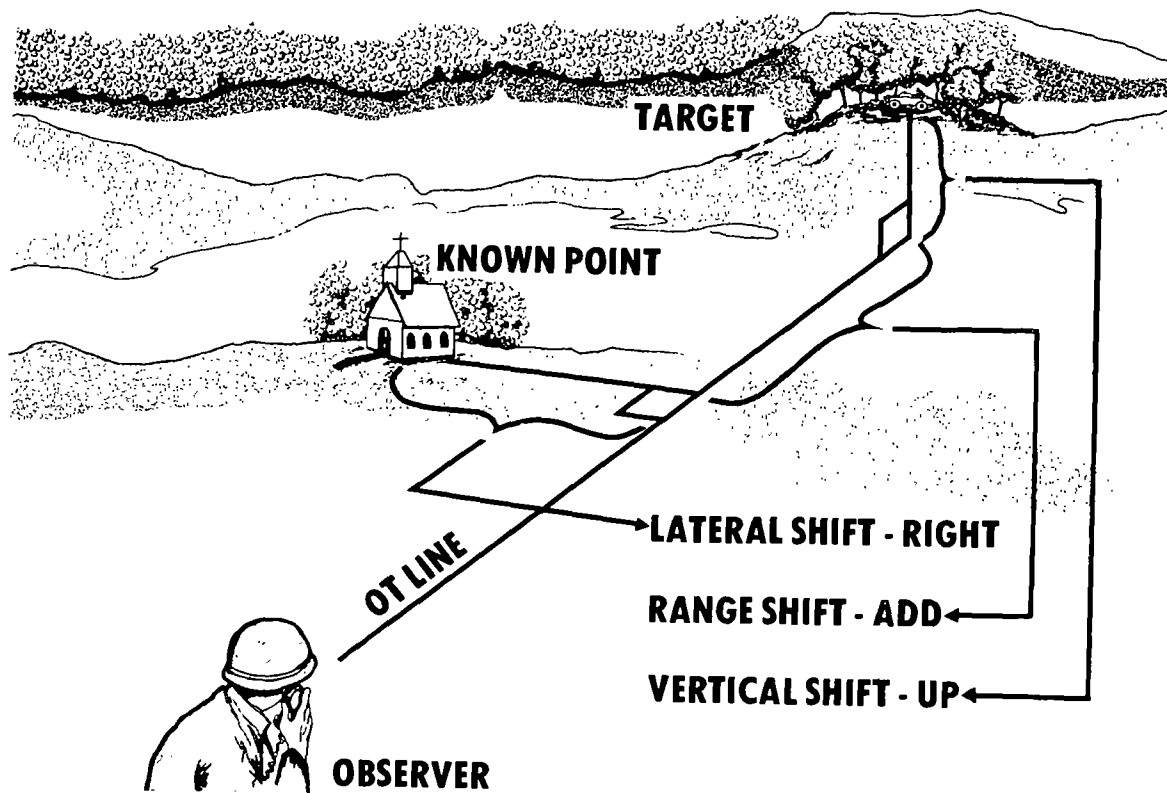
(1) OT direction (see para 5-3d) - Normally direction will be sent to the nearest 10 mils. However, FDCs will be able to handle mils, degrees, or cardinal directions.

(2) Lateral shift (perpendicular to the OT line) - How far *LEFT* or *RIGHT* the target is from the known point (to the nearest 10 meters).

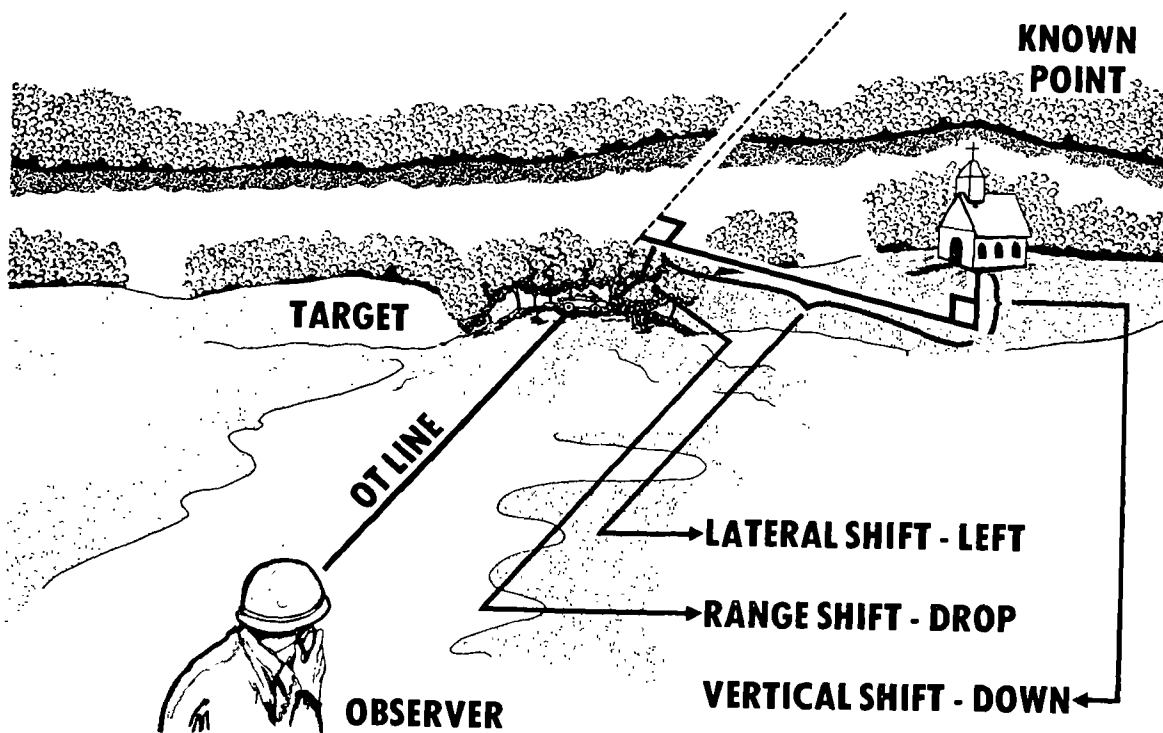
(3) Range shift (along the OT line) - How much further away (*ADD*) or closer (*DROP*) the target is in relation to the known point (to the nearest 100 meters).

(4) Vertical shift - How much the target is above (*UP*) or below (*DOWN*) the altitude of the known point (to the nearest 5 meters). Unless there is an obvious difference, ignore the vertical shift.

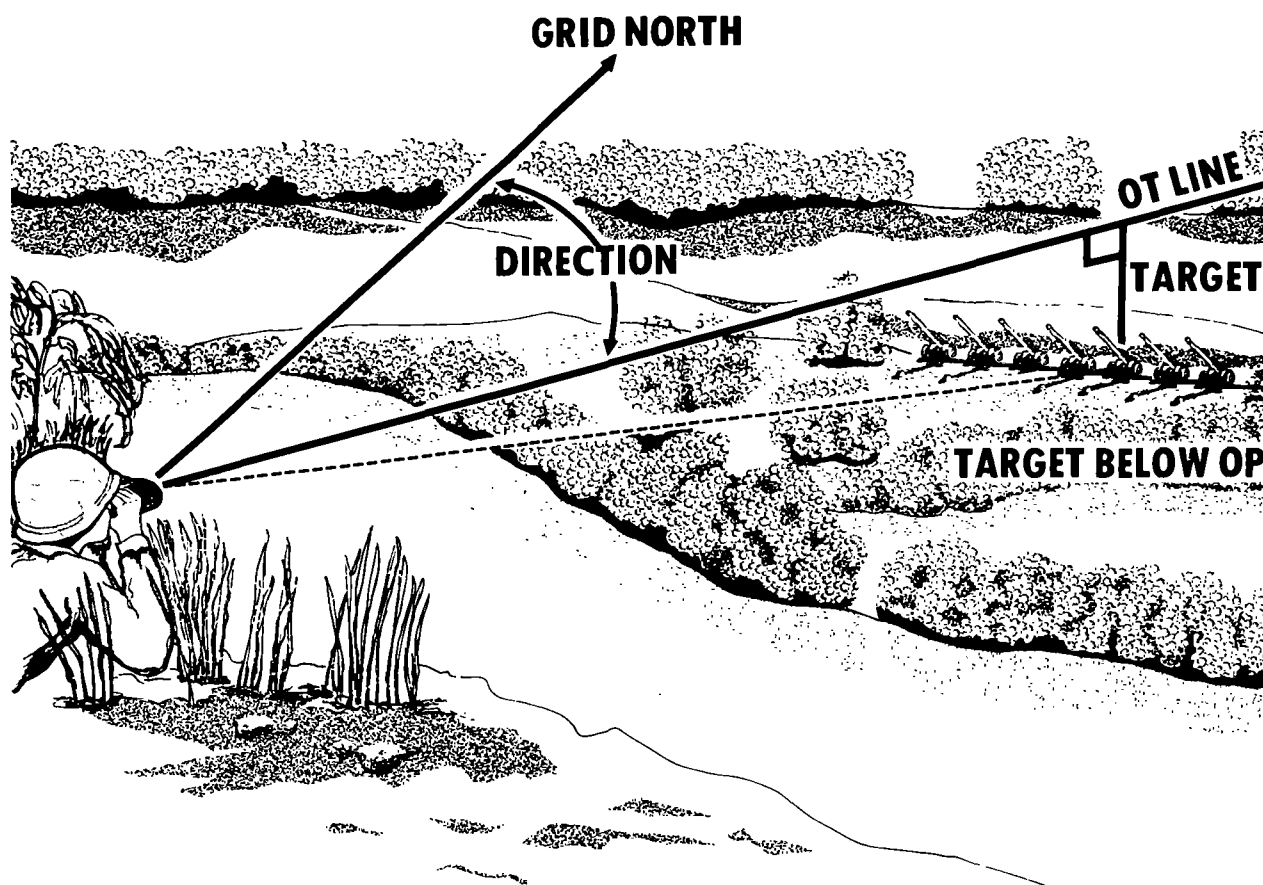
c. Polar plot mission. The word *POLAR* in the method of target location alerts the FDC that you will be locating the target with respect to your position. The FDC then needs the *DIRECTION* (to the nearest 10 mils) and *DISTANCE* (to the nearest 100 meters) from you to the target. A vertical shift to the nearest 5 meters tells the FDC how far the target is located above (*UP*) or below (*DOWN*) your location. Unless there is an obvious difference, ignore the vertical shift.



Target Above Known Point.



Target Below Known Point.

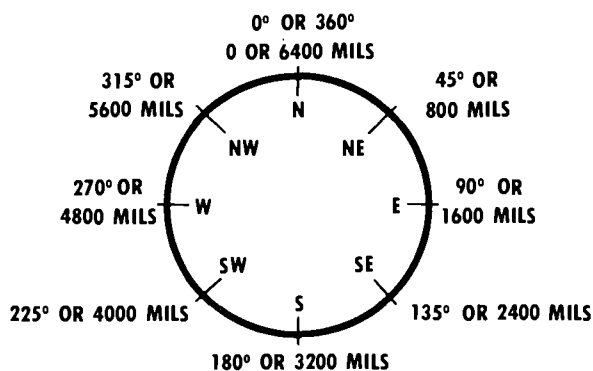


Polar Plot Mission.

d. *Direction.* The FDC must know the direction of the imaginary line (OT line) along which you have determined the target location (for SHIFT and POLAR mission) and from which you will make shifts and corrections. The following are examples of reporting the direction:

- (1) Grid azimuth — DIRECTION 4310.
- (2) Cardinal direction — DIRECTION NORTH-EAST.
- (3) Gun-target line — DIRECTION GUN-TARGET.

A degree equals approximately 17.8 mils. Here is a conversion circle for mils, degrees, and cardinal directions.



5-4. Description of Target

You need to describe the target so that the FDC can determine the amount and type of ammunition to use. The FDC would naturally use different ammo for an antitank squad dug in than for a company of tanks in the open. Be brief but accurate. Basically, your description should contain:

- a. What the target is (troops, equipment, supply dump, trucks, etc).
- b. What the target is doing (digging in, in an assembly area, etc).
- c. Number of elements in the target (squad, platoon, three trucks, six tanks, etc).
- d. Degree of protection (in open, in fox-holes, in bunkers with overhead protection, etc).
- e. A clear description of the target size and shape if these are significant. When the target is rectangular, give the length and width in meters and the azimuth of the long axis to the nearest 50 mils (e.g., *400 BY 200, ATTITUDE 2850*). When the target is circular, give the radius (e.g., *RADIUS 200*).

5-5. Method of Engagement

a. *Type of adjustment.* Either of two types of adjustment may be employed--precision or area. Unless precision fire is specified, area fire will be employed.

(1) Precision fire is conducted with one piece on a point target. It is used to either obtain registration corrections or destroy a target. When the mission is a registration, it is initiated with a message to observer. This is a change from previous procedures in which the registration was initiated with a call for fire. If the target is to be destroyed, the observer will announce *DESTRUCTION*.

(2) Area fire is used for attacking a dispersed target. Since many area targets are capable of movement, the adjustment should be as rapid as possible, consistent with accuracy, to prevent the target from escaping. Select a well-defined point at or near the center of the area to be attacked. This point is called the adjusting point. To achieve sur-

prise, fire may be adjusted on an auxiliary adjusting point and, after adjustment is completed, shifted to the actual target area. Normally, adjustment on an area target is conducted with one adjusting piece. Two pieces fire when the height of burst for fuze time is being adjusted.

(3) The term *DANGER CLOSE* will be included in the element method of engagement when the target is within 600 meters of any friendly troops.

b. *Trajectory.* If high-angle fire is desired, it is requested immediately after the type of adjustment.

c. *Ammunition.* If you do not specify the type of ammunition in the call for fire, you are in effect asking for shell HE with fuze quick to be fired during the adjustment and fire-for-effect phases. If you want a different type of ammunition or fuze action during either the adjustment or the fire-for-effect phase, request it.

(1) Projectile. Examples of requests for other than HE projectile are *ILLUMINATING*, *ICM*, and *HC*.

(2) Fuze. Most missions are fired with fuze quick during the adjustment phase. When requesting a projectile that has but one fuze action, do not indicate the fuze action. Illuminating, ICM, and smoke projectiles are fuzed with time fuzes; therefore, when the observer requests *ILLUMINATING*, *ICM*, or *HC*, he does not announce *TIME*.

(3) Volume of fire. You may request the number of rounds to be fired by the weapons firing in effect; e.g., *3 ROUNDS*.

d. *Distribution.* If you desire other than a parallel sheaf (or a standard sheaf when using terrain gun position corrections) in fire for effect, request, for example, *CONVERGE*, or *SHEAF, 250 METERS*. If the battalion is to fire for effect and you wish to spread the fire for effect, announce *LATERAL SPREAD* or *RANGE SPREAD*. The normal spread is 100 meters. A range or lateral spread for an illuminating mission is 800 meters (1000 meters for M485) between bursts.

5-6. Method of Fire and Control

The method of fire and control element indicates: the desired manner of attacking the target; whether or not you desire to control the time of delivery of fire; and whether or not you can observe the target. Methods of fire and control are announced by the observer by use of the terms below.

a. Method of Fire. In area fire, the adjustment normally is conducted with one of the center platoon howitzers. If for any reason the observer determines that PLATOON RIGHT (LEFT) will be more adequate, he may request it. The normal interval of time between rounds fired by a platoon or battery right (left) is 5 seconds. If the observer wants some other interval, he may so specify.

b. Method of control.

(1) At my command. If you wish to control the time of delivery of fire, include *AT MY COMMAND* in the method of control. When the pieces are ready to fire, the FDC announces:

BATTERY (BATTALION) IS READY, OVER.

You announce *FIRE* when you are ready for the pieces to fire. *AT MY COMMAND* remains in effect *THROUGHOUT THE MISSION* until you announce:

CANCEL AT MY COMMAND, OVER.

(2) Cannot observe. *CANNOT OBSERVE* indicates that you are unable to adjust fire; however, you have reason to believe that a target exists at the given location and that it is of sufficient importance to justify firing on it without adjustment.

(3) Time on target. Tell the FDC when you want the rounds to impact around the target by requesting:

TIME ON TARGET _____ MINUTES FROM . . . NOW, OVER.

or

TIME ON TARGET 0859, OVER.

Note. The FO must insure 0859 on his watch is 0859 on the FDC's watch.

5-7. Correction of Errors

a. Errors are sometimes made in transmitting data or by the FDC personnel in reading back the data. If you realize that you have made an error in your transmission or that the FDC has made an error in the readback, announce *CORRECTION* and transmit the correct data.

Example: You have transmitted:

SHIFT REGISTRATION POINT 2, OVER. DIRECTION 4680, . . .

You immediately realize that you should have sent *DIRECTION 5680*. Announce:

CORRECTION, DIRECTION 5680, OVER.

After receiving the correct read-back, continue to send the remainder of the call for fire.

b. When an error has been made in a subelement and the correction of that subelement will affect other transmitted data, announce *CORRECTION* and then transmit the correct subelement and all affected data in the proper sequence.

Example: You have transmitted:

LEFT 200, ADD 400, UP 40, OVER.

You then realize that you should have sent *DROP 400*. To correct this element, send:

CORRECTION, LEFT 200, DROP 400, UP 40, OVER.

because the *LEFT 200* and *UP 40* may be canceled if they are not included in the corrected transmission.

5-8. Calls for Fire From Headquarters Higher Than Battalion

Calls for fire from higher headquarters and calls for fire from the observer are similar in format. The call for fire from higher headquarters may specify the unit to fire for effect, where the observer's call for fire can only request the fire unit. An example of a call for fire from higher headquarters is as follows:

Warning order

FIRE FOR EFFECT,
BATTALION, OVER.

Target location

TARGET F120 (or GRID
432789 ALT 520),

Method of engagement

VT, 3 ROUNDS,

Control

TIME ON TARGET IS 10
MINUTES FROM. . . NOW,
OVER.

5-9. Message to Observer (MTO)

a. If a target is to be fired on, the fire direction center will furnish you with the following information:

Element	Example 1	Example 2
Battery (batteries) to fire for effect.	BATTALION	ALFA
Adjust battery.	BRAVO	
Any changes or additions to the elements requested by you in the call for fire.	VT IN EFFECT	ICM IN EFFECT
Number of rounds (per tube) in fire for effect.	3 ROUNDS	4 ROUNDS
Additional information.	PE _R -39M ANGLE T-800	TIME OF FLIGHT-18

b. Additional information normally is transmitted separately from the rest of the message to observer. This information is sent at the earliest opportunity. Table 5-1 shows when the information should be sent:

Table 5-1. MTO additional information

Element	When Sent
Probable error range(PE _R)	PE _R ≥ 25M (Precision fire) PE _R ≥ 38M (Area fire) Danger close mission When requested
Angle T	Angle T ≥ 500 When requested
Time of flight	Air observer mission Moving target mission When requested

c. Target numbers will not be assigned to targets of opportunity unless:

(1) You request it (and FDO agrees).

(2) The FDO (or the FSO) directs that it be recorded as a target. The target number will be sent to you at the completion of the mission as follows:

Example:

You send:

LEFT 10, ADD 10, RECORD
AS TARGET, END OF MIS-
SION, ESTIMATE 6 CAS-
UALTIES, OVER.

The FDC agrees with you.

FDC sends

to you:

LEFT 10, ADD 10, RECORD AS
TARGET, END OF MISSION,
ESTIMATE 6 CASUALTIES,
TARGET 801, OVER.

You send:

TARGET 801, OUT.

*The FDC will send you
the replot grid as soon
as it is available.*

d. MTO's for high-burst, mean-point-of-impact, and radar registrations remain unchanged (see chapter 6 for precision registration MTO's).

5-10. Authentication

a. Excluding unique fire support operations (e.g., dedicated battery, suppressive fires posture) challenge and authentication is considered a NORMAL element of initial requests for artillery fire. The FDC inserts the challenge in the last readback of the fire request (see examples paragraphs 5-11 through 5-13). The FO transmits the correct authentication reply to the FDC immediately following the challenge (normally 5-7 seconds, never more than 15-20 seconds), during the time the FDC is processing the fire request. Authentication replies exceeding 15-20 seconds are automatically suspect and a basis for rechallenge. Subsequent adjustment of fire or *immediate* engagement of additional targets by the FO originating the initial fire request would not normally require continued challenge by the FDC.

b. With properly trained personnel, challenge and authentication procedures should not reduce responsiveness. When the battery is in a unique *high response posture* (e.g., dedication), the FDO must exercise strong judgment before deferring authentication. Some things the FDO must consider are:

(1) Is the station requesting fire an untrained observer? FA observers will be trained to expect a request for authentication and should know how to properly and rapidly authenticate. Untrained observers (e.g., maneuver personnel requesting fire) may not

be as proficient in authentication and some delay from them may be expected.

(2) Have problems been experienced with enemy personnel using imitative deception, calling for fire, etc.; the more frequent the occurrence, the more careful the FDO must be.

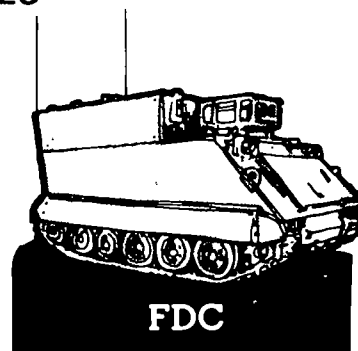
(3) How close is the reported target location to friendly elements? The closer the location is to friendly positions, the more careful the FDO should be.

(4) Is it an AF or FFE mission? More care must be taken with FFE missions since these have the greatest potential for wasting ammunition and harming friendly troops. In a high response posture, challenge and authentication may have to be deferred until the first round(s) are on the way, but should be accomplished as soon as possible (prior to subsequent adjustment).

c. The FDO must weigh the above factors and decide in his own mind which would do more harm - withholding fire until proper authentication is received or possibly firing (at least the initial volley) for an enemy station. For example, for an immediate suppression mission from an untrained observer, with the target 1500 meters distance from reported friendly locations, the FDO might decide that more harm would be done by withholding fire for proper authentication than would be done if the station requesting fire were an unauthorized station.

Section II. EXAMPLES

5-11. Fire Mission (Grid)

*Initial Fire Request*

Z57, THIS IS Z71, ADJUST FIRE,
OVER.

o
o

GRID 180513, OVER.

o
o

INFANTRY PLATOON IN THE OPEN,
VT IN EFFECT, OVER.

o
o

I AUTHENTICATE CHARLIE, OUT.

o
o
o
o
o
o
o

BRAVO, 2 ROUNDS, OUT.

o
o
o
o
o
o
o

DIRECTION 1650, OVER.

Z71, THIS IS Z57, ADJUST FIRE,
OUT.

o
o

GRID 180513, OUT.

o
o

INFANTRY PLATOON IN THE OPEN,
VT IN EFFECT, AUTHENTICATE
PAPA BRAVO, OVER.

o
o
o
o
o
o
o

BRAVO, 2 ROUNDS, OVER.

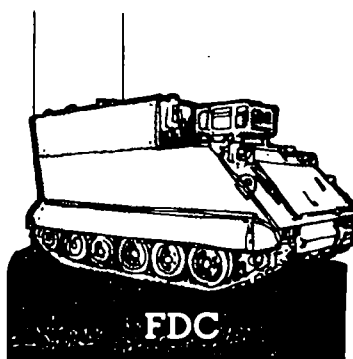
o
o
o
o
o
o
o

DIRECTION 1650, OUT.

Message to Observer

Direction (must be sent before or with first correction)

5-12. Fire Mission (Polar Plot)



Initial Fire Request

Z56, THIS IS Z31, FIRE FOR EFFECT,
POLAR, OVER.

o
o
o

DIRECTION 4520, DISTANCE 2300,
DOWN 35, OVER.

o
o
o

INFANTRY COMPANY IN OPEN,
ICM, OVER.

o
o

I AUTHENTICATE ECHO, OUT.

o
o
o
o
o

BATTALION, VT, 3 ROUNDS, OUT.

Z31, THIS IS Z56, FIRE FOR EFFECT,
POLAR, OUT.

o
o
o

DIRECTION 4520, DISTANCE 2300,
DOWN 35, OUT.

o
o
o

INFANTRY COMPANY IN OPEN,
ICM, AUTHENTICATE TANGO FOX-
TROT, OVER.

o
o
o
o

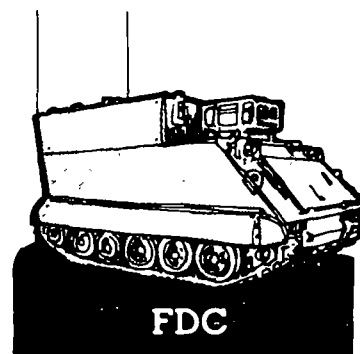
BATTALION*, VT**, 3 ROUNDS,
OVER.

*Message to Observer**

*Bn FDO directed a battalion mass mission

**FDO changed shell to HE/VT

5-13. Fire Mission (Shift From a Known Point)



Initial Fire Request

H66, THIS IS H44, ADJUST FIRE, SHIFT 732, OVER.

o
o
o

DIRECTION 5210, LEFT 380, ADD 400 DOWN 25, OVER.

o
o
o

COMBAT OP IN OPEN, ICM, OVER.

o
o
o

I AUTHENTICATE PAPA, OUT.

o
o
o
o
o
o

CHARLIE, 1 ROUND, OUT.

THIS IS H66, ADJUST FIRE, SHIFT 732, OUT.

o
o
o

DIRECTION 5210, LEFT 380, ADD 400, DOWN 25, OUT.

o
o
o

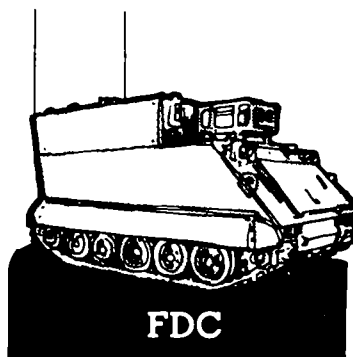
COMBAT OP IN OPEN, ICM, AUTHENTICATE ZULU FOX-TROT, OVER.

o
o
o
o
o
o

CHARLIE, 1 ROUND, OVER.

Message to Observer

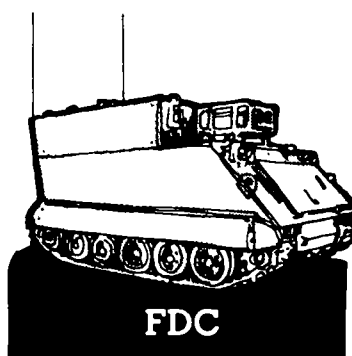
5-14. Suppress



H18, THIS IS H24, SUPPRESS 31, OVER.

THIS IS H18, SUPPRESS 31, OUT.

5-15. Immediate Suppression



THIS IS H24, IMMEDIATE SUPPRESSION, GRID 211432, OVER.

THIS IS H69, IMMEDIATE SUPPRESSION, GRID 211432, OUT.

CHAPTER 6

ADJUSTMENT PROCEDURES



CHAPTER 6

ADJUSTMENT PROCEDURES

Section I. AREA FIRE

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Section II. PRECISION FIRE

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Section I. AREA FIRE

6-1. General

This chapter explains specific procedures to be used when conducting area or precision fire missions. The basic fundamentals contained in FM 6-40 (June 1974) have been expanded to simplify procedures and clarify discrepancies.

6-2. Deviation Corrections

Deviation corrections of 20 meters or less will be ignored during any area fire mission, except when providing final refinement data.

6-3. When to Fire For Effect

Constantly strive to get the maximum number of rounds on the target in the shortest possible time. The preferred methods for doing this are:

a. First round fire for effect. If the target location is accurate and the first rounds out will have effect on the target, request *FIRE FOR EFFECT*.

b. Bold shift. If possible use the first round out to make a bold shift to place the next round on the target; i.e., *FIRE FOR EFFECT*.

c. If neither *a* nor *b* is possible, attempt to get two rounds (one over and one short) to bracket the target as quickly as you can. Then, using the distance between the two rounds as a yardstick, make a correction to place the next rounds on the target.

d. In some cases you will have to successively split a bracket to insure effect on the target.

6-4. Irregularly-Shaped Targets

When calling for fire on an irregularly-shaped target, describe the target in sufficient detail to allow the FDO to make a decision as to the best method of attack. In addition to providing the location of the *TARGET CENTER*, provide the length in meters, the depth in meters, and the target attitude. The target attitude is best described as a clockwise angle in mils from grid north. An estimated deviation from a cardinal direction or another clear, brief description may be used.

You may also designate the target by announcing, in the same call for fire, two or more grids that, when plotted, indicate the size and shape of the target.

H18 THIS IS H24, OVER.

GRID 948177, OVER.

SUSPECTED ATGM POSITIONS
IN TREELINE, LENGTH 400,
ATTITUDE 2100, RECORD AS
TARGET 161, OVER.

ATTITUDE 2100

LENGTH 400M

GRID 941877

TREELINE

H18 THIS IS H24,
FIRE FOR EFFECT, OVER.

GRIDS 167194 AND 169198
AND 171194, OVER.

INFANTRY COMPANY IN
TREELINE, OVER.

GRID 169198

GRID 167194

GRID 171194

6-5. Dissipating Targets

A dissipating target is a target revealed by some signature associated with enemy activity such as a flash, a puff of smoke, noise, dust, a slight movement, or a reflection. By rapid association of a terrain feature close to the signature, you can engage the target by

using the terrain feature as an adjusting point. The target description should include the suspected target identification.

6-6. Danger Close

a. The creeping method of adjustment will be used exclusively during *DANGER CLOSE* missions.

b. Corrections must be made keeping in mind positions of all nearby friendly troops. Care must be taken to insure that a correction will not cause rounds to endanger friendly troops.

c. All weapons which will fire for effect normally will be used in adjustment.

(1) Current Terrain Gun Position Correction (TGPC) procedures (see Chapter 10) are designed to obtain a desired sheaf (burst pattern) in the target area. To achieve acceptable sheafs, the crossing of trajectories has been accepted. Thus, the piece closest to "friendlies" along the GT line may not provide the closest burst in the target area.

Using TGPC the possibility of a particular weapon firing the wrong set of corrections also exists.

(2) Targets engaged in danger close missions are, for the most part, not point targets. Thus, adjusting with the entire firing element will be bringing fires on the enemy (i.e., throughout his elements) during the adjustment.

d. For battalion missions firing elements should be adjusted individually. The battalion danger close fire mission would then essentially be handled as 3 separate battery danger close missions.

e. *COMMON SENSE, RATHER THAN IRONCLAD RULES, SHOULD BE USED IN DETERMINING HOW DANGER CLOSE MISSIONS (OR ANY OTHER MISSIONS FOR THAT MATTER) ARE HANDLED.* For example, if TGPC are not being used and ammunition is critically short, then adjustment with only one weapon would be the appropriate technique.

Section II. PRECISION FIRE

6-7. General

The precision fire procedures, (previously known as ABCA procedures) discussed in this section replace the old "FORK BRACKET" procedures as the primary means of conducting precision missions. *THE ABCA PROCEDURES PLACE A GREAT DEAL MORE RESPONSIBILITY ON THE OBSERVER THAN DID THE FORK BRACKET PROCEDURES.* There are two types of precision missions:

- a. Precision registration.
- b. Destruction mission.

6-8. Precision Registration

a. *General.* A registration is conducted with a single piece, normally the base piece of the firing battery. The FDO normally directs you to conduct the registration on a designated point. Occasionally, however, you may be directed to select the registration point.

b. *Call for fire.* The precision registration is initiated with a message to observer.

(1) *Example 1.* Registration on a known point.

FDC TO FO: H18 THIS IS H44,
REGISTER ON
REG PT 2, QUICK
AND TIME, OVER.
(Read back by FO.)

FO TO FDC: DIR 6400, OVER.*
(Read by FDC.)

FDC TO FO: SHOT, OVER.

(2) *Example 2.* Registration point selected by observer.

FDC TO FO: H18 THIS IS H44,
SELECT REG PT 1
VICINITY GRID
6138, QUICK AND
TIME, TWO LOTS,
OVER. (Read
back by Observer.)

FO TO FDC: **GRID 6124 3843****,
DIR 6310, OVER.*
 (Read back by FDC.)

FDC TO FO: **SHOT, OVER.**

*The FO's response to the message to observer indicates that he is ready to observe.

**The FO sent an 8-digit grid coordinate for the registration.

c. Observer procedure (impact portion).
THE OBJECTIVE OF AN IMPACT REGISTRATION IS TO OBTAIN SPOTTINGS OF TWO OVERS AND TWO SHORTS ALONG THE OBSERVER-TARGET LINE FROM ROUNDS FIRED WITH THE SAME DATA OR FROM ROUNDS FIRED WITH DATA 25 METERS APART (50M WHEN PE_R IS GREATER THAN OR EQUAL TO 25M).

This normally requires the spottings from four separate rounds; however, a target hit or a round that is spotted as range correct provides spottings of both an over and a short. Thus, the objective could be achieved with two consecutive target hits or range correct spottings. The following rules and procedures are applicable:

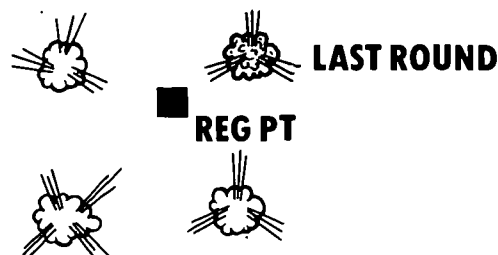
(1) Deviation corrections are normally not made unless the correction is necessary to obtain a range spotting (i.e., prevent a spotting of DOUBTFUL).

(2) When the 50-meter range bracket has been established, two rounds must be fired with data 25 meters in the direction opposite that of the last range spotting. If both rounds result in spottings of *SHORT (OVER)*, you must *ADD (DROP)* 25 meters and continue firing until two definite range spottings have been obtained at the opposite end of the 25-meter range bracket.

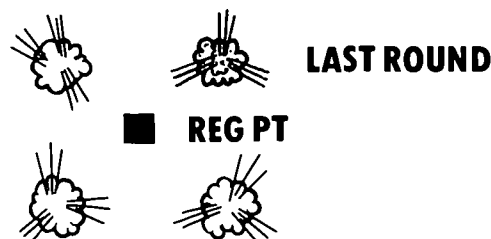
(3) When the requirement of two overs and two shorts with the same data or data fired 25 meters apart has been met, end the impact registration with necessary refinement data. Refinement data may include either a range correction or a lateral correction, or both, to the nearest 10 meters.

(4) When determining refinement data, determine the location of the registration point with respect to the two sets of spottings

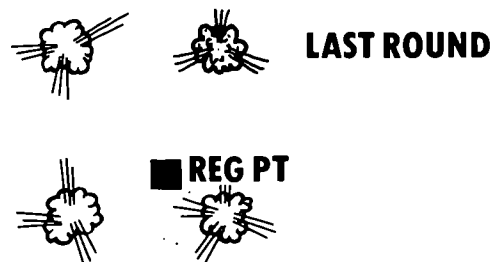
and then determine and announce refinement data. The criteria for announcing refinement data are as follows:



(a) If the registration point is nearer the spotting(s) of the last round(s) fired, *NO REFINEMENT* is necessary.



(b) If the registration point is equidistant between the two sets of bursts, the observer announces *ADD OR DROP 10* from the last data fired.

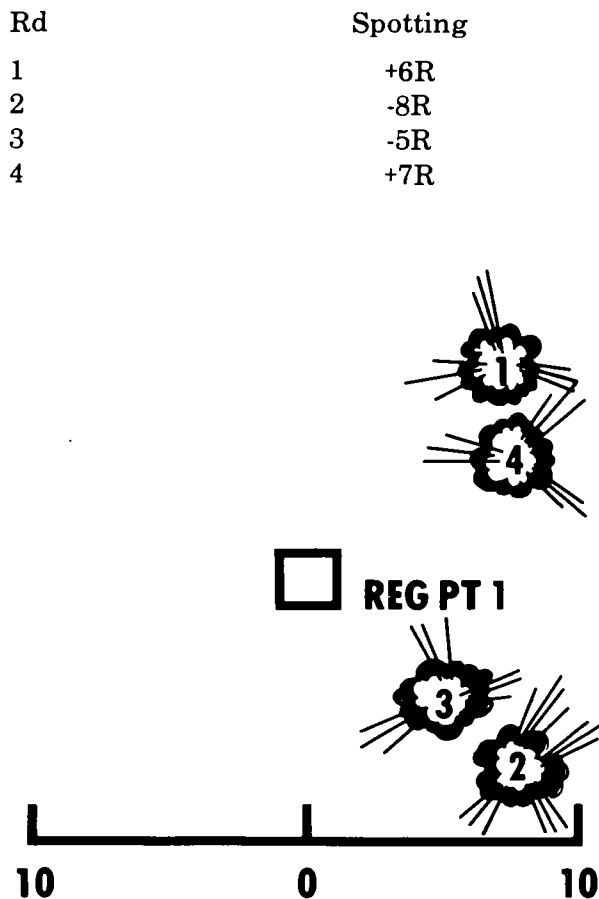


(c) If the registration point is nearer the pair of bursts at the opposite end of the bracket, the observer announces *ADD OR DROP 20*.

YOU MUST KEEP TRACK OF THE ROUNDS AND HOW YOU SPOT THEM IN RELATION TO THE REGISTRATION POINT. THIS IS MOST EASILY ACCOMPLISHED BY NUMBERING THE ROUNDS.

(5) Make deviation spottings to an accuracy of 1 mil when spotting rounds during a precision mission. The deviation refinement is determined by adding the spotting deviations of the rounds establishing the two overs and two shorts (this may be 2, 3, or 4 deviations). This total is then divided by the number of rounds (2, 3, or 4) to get an average deviation expressed to nearest mil. The average deviation times the OT factor equals the correction.

Example 1



SUM OF DEVIATIONS

$$6R + 8R + 5R + 7R = 26R$$

AVERAGE DEVIATION

$$26R \div 4 \text{ rds} = 6.5R \approx 6R$$

$$OT = 3$$

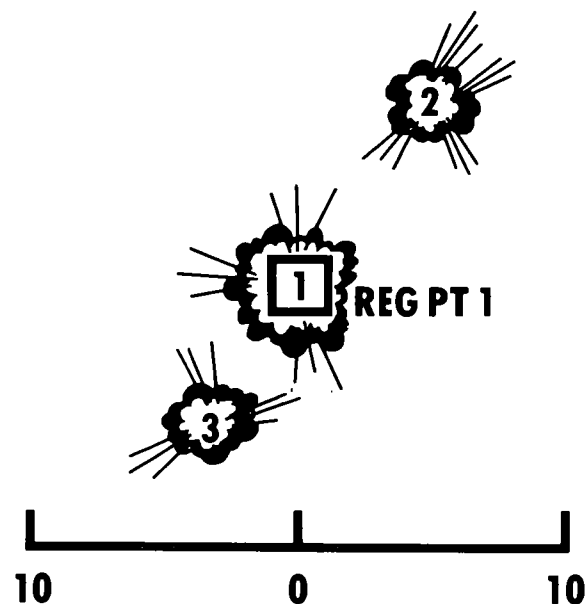
$$MPI \text{ is } 3 \times 6R = 18M R \approx 20M R$$

CORRECTION IS:

LEFT 20, DROP 10, RECORD AS REGISTRATION POINT 1, END OF MISSION, OVER.

Example 2

Rd	Spotting
1	Target
2	+7R
3	-3L



SUM OF DEVIATIONS

$$0 + 7R + 3L = 4R$$

AVERAGE DEVIATION

$$4R \div 3 \text{ rds} = 1.33R \approx 1R$$

$$OT = 2$$

$$MPI \text{ is } 2 \times 1R = 2M R \approx 0$$

CORRECTION IS:

ADD 10, RECORD AS REGISTRATION POINT 1, END OF MISSION, OVER.

d. Observer procedures (time portion).

(1) If a time registration is required after the impact registration has been completed, determine and announce refinement data and commands for the time registration.

Example: RIGHT 10, ADD 10, RECORD AS REGISTRATION POINT 1, TIME REPEAT, OVER.

(2) **ADJUST THE MEAN HEIGHT OF BURST OF FOUR ROUNDS FIRED WITH THE SAME DATA TO 20 METERS ABOVE THE REGISTRATION POINT.** Procedures for the conduct of the time registration are as follows:

(a) If the first round is *GRAZE*, give the correction *UP 40*. The FDC, using Δ FS, raises the height of burst in 40-meter increments until a spotting of *AIR* is obtained.

(b) Once an airburst has been obtained, command 3 *ROUNDS REPEAT*.

(c) When four rounds have been fired with the same data, end the time registration with the appropriate correction to achieve a 20-meter height of burst.

Example: UP 10, RECORD AS TIME REGISTRATION POINT 1, END OF MISSION, OVER.

(d) The possible spottings and observer corrections in a time registration are as follows:

■ Four air. The height-of-burst is **CORRECTED TO 20 METERS** in 5-meter increments. It has been found that the simplest method of determining the mean height-of-burst is to add the four spottings in mils, divide by 4, express to nearest mil, then multiply by the OT factor (the same technique used in determining deviation corrections).

■ Three air and one graze. The height-of-burst is **CORRECT**.

■ Two air and two graze. The height-of-burst is corrected by *UP 10*.

■ One air and three graze. The height-of-burst is corrected by *UP 20*.

(3) Check rounds may be fired from other weapons in the battery to verify the validity of the time registration.

e. Additional examples. Tables 6-1 through 6-3 address some of the contingencies that may confront you. They are intended as aids to learning, not as "crutches" that you must have in order to conduct a registration. Each table represents a separate precision registration. The instructions for using each table are as follows:

(1) Each table is a continuation of the mission described on the left side of each table.

(2) The round that splits the appropriate range bracket or provides a range correct/target hit spotting in the adjustment phase is the first round of the table.

(3) The round number(s), spotting(s), and the observer's correction are given for each step of the table. In table 6-1, for example, *RD 5 (-) ② +25* indicates that the observer's spotting for round 5 was *SHORT* and his correction was

2 ROUNDS, ADD 25, OVER.

(4) Some of the contingencies that may occur following the observer's correction are presented after each step. The user of the table simply picks the contingency that he is concerned with, determines the appropriate observer correction, and then moves on to the listed contingencies after this latest correction. This process continues until the impact registration is terminated.

(5) It should be noted that each completed mission is terminated by the words **RECORD AS REG PT**____. (Use spottings from rounds (so and so).) Each completed mission is terminated in this manner for simplicity; in most missions refinement data would be required prior to the observer's com-

mand to record as registration point; for example:

RIGHT 10, ADD 10, RECORD AS REG PT 2, END OF MISSION, OVER.

or if a time registration is also to be conducted:

RIGHT 10, ADD 10, RECORD AS REG PT 2, TIME REPEAT, OVER.

Table 6-1. ADD 25 at Round 5.

RD 2 L50 +200 RD 3 -100 RD 4 +50 RD 5 (-) ② +25 (See note 2.)	RD 6 & 7 (+,+) ① -25	RD 8 (-)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,8.)
		RD 8 (RG CORR/TGT)	RECORD AS REG PT____. (Use spottings from rounds 5,7,8.)
		RD 9 (-)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,9.)
		RD 8 (+) RPT	RD 9 (+) -25 (See note 4.)
		RD 9 (RG CORR/TGT)	RECORD AS REG PT____. (Use spottings from rounds 5,8,9.)
		RD 8 (+)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,8.)
		RD 8 RG CORR/TGT	RECORD AS REG PT____. (Use spottings from rounds 6,7,8.)
		RD 8 (-)	RECORD AS REG PT____. (Use spottings from rounds 3,6,7,8.)
		RD 6 & 7 (-,-) ① +25 (See note 4.)	
		RD 6 & 7 (-,+) ① RPT	

Table 6-2. DROP 25 at Round 5

RD 2 L50 +200 RD 3 -100 RD 4 +50 RD 5 (+) ② -25	RD 6 & 7 (-,-) ① +25	RD 8 (+)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,8.)
		RD 8 (RG CORR/TGT)	RECORD AS REG PT____. (Use spottings from rounds 5,7,8.)
		RD 9 (+)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,9.)
		RD 8 (-) RPT	RD 9 (RG CORR/TGT) RECORD AS REG PT____. (Use spottings from rounds 5,8,9.)
		RD 9 (-) +25	(See note 4.)
		RD 8 (-)	RECORD AS REG PT____. (Use spottings from rounds 5,6,7,8.)
		RD 8 (RG CORR/TGT)	RECORD AS REG PT____. (See note 3.) (Use spottings from rounds 6,7,8.)
		RD 8 (+)	RECORD AS REG PT____. (Use spottings from rounds 4,6,7,8.)
		RD 6 & 7 (+,-) ① RPT	
		RD 6 & 7 (+,+) ① -25 (See note 4.)	

Table 6-3. Range Correct/Target During Adjustment.

RD 2 L50 +200 RD 3 (TGT) RPT (See notes 1 & 3.)	RD 4 (+) -25	RD 5 (+) -25	(See note 4.)
		RD 5 (-)	RECORD AS REG PT_____. (Use spottings from rounds 3,4,5.)
		RD 5 (RG CORR/TGT)	RECORD AS REG PT_____. (See note 5.) (Use spottings from rounds 3,5.)
	RD 4 (RG CORR/TGT)		RECORD AS REG PT_____. (See note 3.) (Use spottings from rounds 3,4.)
	RD 4 (-) +25	RD 5 (-) +25	(See note 4.)
		RD 5 (+)	RECORD AS REG PT_____. (Use spottings from rounds 3,4,5.)
		RD 5 (RG CORR/TGT)	RECORD AS REG PT_____. (See note 5.) (Use spottings from rounds 3,5.)

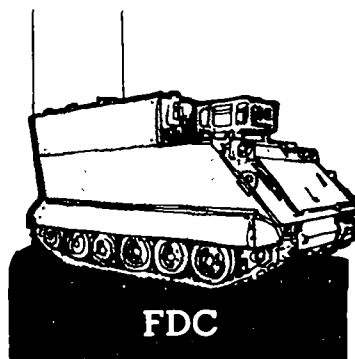
Notes:

1. If a round is spotted as range correct or target during the adjustment, the observer continues the mission with REPEAT (round 3, table 6-3).
2. If the spotting of the round as a result of the observer's correction of ADD or DROP 50 is in the same sense as that of the previous round, the observer uses the spottings and corrections beginning at round 5 and continues in the normal manner.
3. A round spotted as range correct or target may be equivalent to a pair of rounds at the same data bracketing the registration point.
4. The observer continues range corrections in 25-meter increments until a spotting of range correct or target or a spotting in the opposite sense is obtained and then orders corrections, as appropriate, to obtain a verified bracket. If two or three 25-meter range corrections result in spottings the same as the preponderance, the observer may assume that he obtained a false bracket. The observer should continue the mission by establishing a new bracket.
5. The observer ends the registration, since the equivalent of two pairs of rounds fired at data 25 meters apart bracketing the registration point has been obtained.

6-9. Example of Registration Mission



FO



FDC

Message to Observer

J79 THIS IS J53, REGISTER ON
REGISTRATION POINT 3, QUICK
AND TIME, OVER.

J53 THIS IS J79, REGISTER ON
REGISTRATION POINT 3, QUICK
AND TIME, OUT.

DIRECTION 1620, OVER.

DIRECTION 1620, OUT.

SHOT, OUT.

SHOT, OVER.

LEFT 60, ADD 200, OVER.

LEFT 60, ADD 200, OUT.

SHOT, OUT.

SHOT, OVER.

DROP 100, OVER.

DROP 100, OUT.

SHOT, OUT.

SHOT, OVER.

DROP 50, OVER.

DROP 50, OUT.

SHOT, OUT.

SHOT, OVER.

TWO ROUNDS, ADD 25, OVER.

Impact Portion

SHOT, OUT.

ROUNDS COMPLETE, OUT.

ONE ROUND, DROP 25, OVER.

SHOT, OUT.

LEFT 20, ADD 10, RECORD AS REGISTRATION POINT 3, TIME REPEAT, OVER.

SHOT, OUT.

UP 40, OVER.

SHOT, OUT.

THREE ROUNDS REPEAT, OVER.

SHOT, OUT.

ROUNDS COMPLETE, OUT.

UP 10, RECORD AS TIME REGISTRATION POINT 3, END OF MISSION, OVER.

Time Portion

TWO ROUNDS, ADD 25, OUT.

SHOT, OVER.

ROUNDS COMPLETE, OVER.

ONE ROUND, DROP 25, OUT.

SHOT, OVER.

LEFT 20, ADD 10, RECORD AS REGISTRATION POINT 3, TIME REPEAT, OUT.

SHOT, OVER.

UP 40, OUT.

SHOT, OVER.

THREE ROUNDS REPEAT, OUT.

SHOT, OVER.

ROUNDS COMPLETE, OVER.

UP 10, RECORD AS TIME REGISTRATION POINT 3, END OF MISSION, OUT.

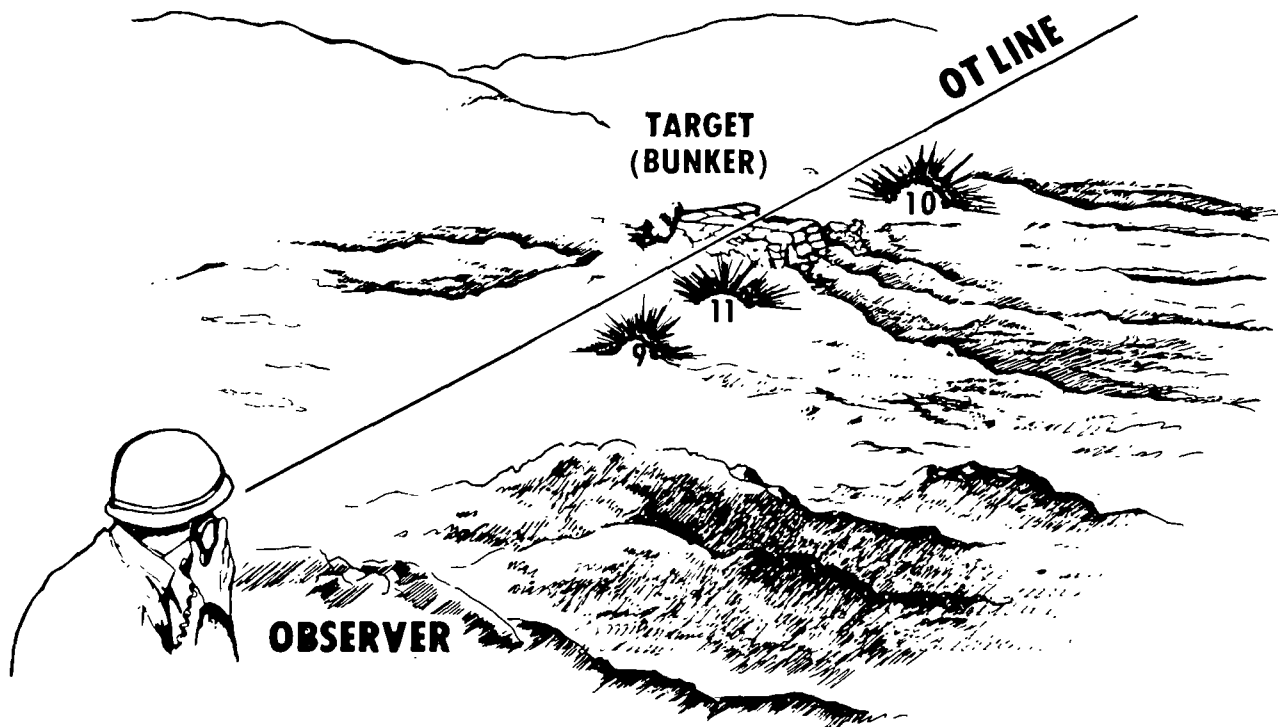
6-10. Destruction Missions

a. General. A destruction mission is simply a continuation of an impact registration. Once you have made your refinement for the impact portion, continue to fire additional rounds. After every third round make an additional refinement and continue to fire

until you destroy the target or the mission is stopped for some operational reason. You may make corrections after every round if you desire to do so.

b. Example: The FO makes his refinement.

OT FACTOR = 2



Round	Spotting	Correction
9	-4R	ADD 10 ¹
10	+5R	REPEAT
11	-4R	REPEAT
12	RC 1L	LEFT 10 ²
13	TGT	REPEAT
		EM BUNKER DESTROYED ³

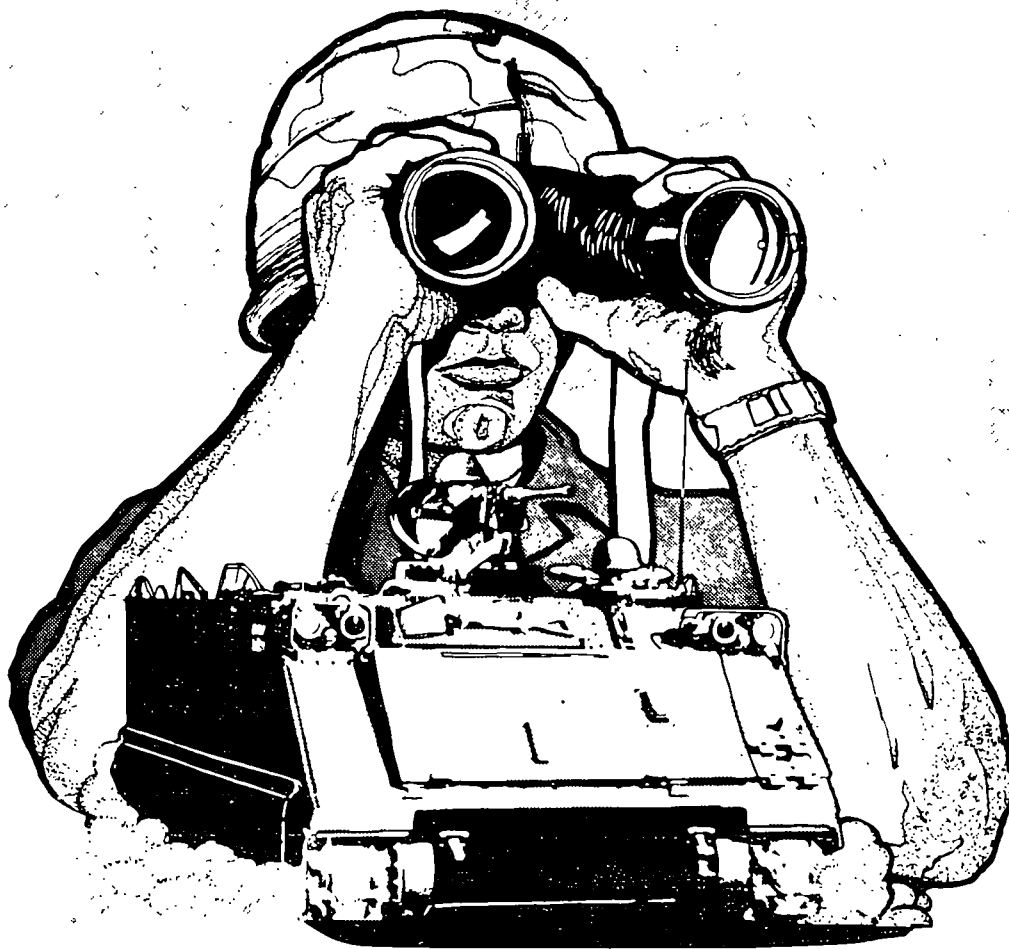
¹TARGET WAS MIDWAY BETWEEN THE 4 SPOTTING ROUNDS

²PREPONDERANCE WAS $\frac{4R + 5R + 4R}{3} = \frac{13R}{3} = 4.3R \approx 4R \times 2 \text{ (OT FACTOR)} = 8M R \approx \text{(CORRECTION) L10M}$

³MISSION ENDED SINCE TARGET WAS DESTROYED

CHAPTER 7

OBSERVER PROCEDURES FOR SPECIAL SITUATIONS



**HOW THE FORWARD OBSERVER
CAN DELIVER EFFECTIVE FIELD ARTILLERY FIRE**

CHAPTER 7

OBSERVER PROCEDURES FOR SPECIAL SITUATIONS

Section I. CONDUCT OF FIRE WITH IMPROVED CONVENTIONAL MUNITIONS (ICM)

Paragraph		Page
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7-5	Employment Considerations	7-7
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Section II. COUNTERFIRE

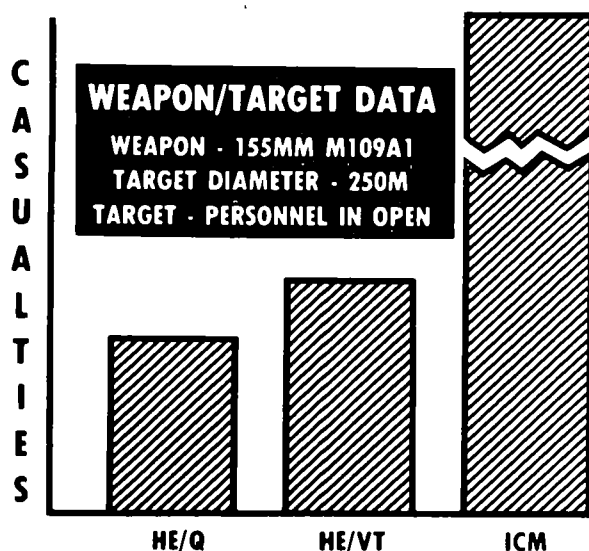
7-9	General	7-19
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7-11	Immediate Counterfire	7-19

Section I. CONDUCT OF FIRE WITH IMPROVED CONVENTIONAL MUNITIONS (ICM)

7-1. Improved Conventional Munitions

a. General. The ICM projectile contains a number of grenades (submissiles). The projectile merely carries the grenades to the target area — the grenades do all the work. Using these grenades, ICM rounds distribute their lethality over a large area rather than concentrating it in a limited area of wasted overkill. Thus, the effects of a battery volley of ICM will cover a much larger area than most munitions.

ICM MAKES UP A LARGE PART OF EACH UNIT'S BASIC LOAD. LEARN HOW TO EMPLOY IT RESPONSIVELY.



SAME NUMBER OF ROUNDS FIRED

b. Effectiveness. The ICM round is *most* effective against soft targets such as troops in the open. In fact, it is our most effective round against these type targets. The effectiveness of ICM is seriously degraded if the enemy has time to seek cover. The key to proper ICM use is to *GET THE ROUNDS ON TARGET QUICKLY*.

WITH ICM, SURPRISE FIRE WILL NORMALLY PRODUCE BETTER RESULTS THAN WILL PINPOINT ACCURACY AFTER AN ADJUSTMENT.

If you feel that you are within 200 meters of the target with your initial location, *FIRE FOR EFFECT*. If you are unsure of the target location, a single adjusting round should be fired, a bold shift made, and fire for effect requested.

c. The call for fire. Improved conventional munitions may be fired using three procedures:

(1) Transfer (FFE) using current HE corrections.

(2) Adjustment with HE and firing ICM in effect.

(3) Adjustment with ICM.

Transfer using current HE corrections is most desirable. Surprise (critical with ICM) will be achieved with this technique.

J31 THIS IS J51, *FIRE FOR EFFECT*, OVER. GRID 364298, OVER. PLATOON IN THE OPEN, *ICM*, OVER.

When current corrections are not available, fire one HE round onto a point near the target and then make a bold shift and fire for effect with ICM.

J31 THIS IS J51, *ADJUST FIRE*, POLAR, OVER. DIRECTION 2610, DISTANCE 2100, OVER. TANKS WITH DISMOUNTED INFANTRY, *ICM IN EFFECT*, OVER.

The least preferable procedure is to adjust with ICM because of the resultant loss of responsiveness and surprise.

J31 THIS IS J51, *ADJUST FIRE*,
OVER. GRID 361290, OVER. COM-
PANY ASSEMBLY AREA, *ICM*,
OVER.

By not specifying ICM "in effect" you indicate that you desire to adjust with ICM.

d. Adjustment of ICM.

(1) General. Procedures for the adjustment of ICM are similar to the procedures used for a normal HE adjustment.

(2) Range and deviation. Range and deviation are adjusted from the center of the effects pattern. Since ICM is most effective when delivered as surprise fires, make a bold shift from the center of the initial effects pattern and fire for effect.

(3) Height of burst. A height of burst which is too high is normally not critical. *ATTEMPTS TO ADJUST THE HOB SHOULD NORMALLY NOT BE MADE.* However, if a large number of bomblet duds are observed or the effects pattern is too small, then the HOB is too low; correct the HOB by raising it in 50 meter increments

until the desired results are obtained.

(4) Danger close. When adjusting close-in fires with ICM, start the adjustment at least 600 meters from friendly troops, depending on the relative locations of weapons, target, and friendly troops. Special considerations must be given to the direction and speed of the wind in the target area. The adjustment should be made with the entire battery and corrections should be made from the *NEAR EDGE OF THE EFFECTS PATTERN.*

e. Safety considerations.

(1) If ICM is fired into heavy foliage or trees, grenade vanes or ribbons may be caught in branches. Normally, these grenades do not detonate but they do remain armed. Caution must be exercised prior to having friendly troops travel through such areas after ICM has been fired.

(2) Grenade malfunctions (duds) do occur, particularly when there is a low air burst functioning of the projectile. Duds should be treated as potential mines or booby traps and must be reported.

Section II. CONDUCT OF FIRE WITH SMOKE

7-2. General Employment



Smoke generally is not equated to combat power because it is not lethal. Nevertheless, when used correctly, it can significantly reduce the enemy's effectiveness both in the daytime and at night. Smoke, combined with other suppressive fires, will provide increased opportunities for maneuver forces to deploy, thus enhancing the chances of mission accomplishment without catastrophic losses while operating on the highly lethal modern battlefield. Smoke attenuates laser beams

and inhibits the use of optically-guided missiles, such as the SAGGER. Smoke may be used to reduce the ability of the enemy to deliver effective fires, to hamper hostile operations, and to deny the enemy information on friendly positions and maneuver. The effective delivery of smoke by the field artillery at the critical time and place on the battlefield will contribute significantly to the combined arms team winning the first battle of the next war.

THE THINKING MAN'S AMMUNITION

7-3. Employment of Field Artillery Smoke.

a. Field artillery smoke is employed to--

OBSCURE ENEMY VISION



OBSCURATION - Smoke placed on or near the enemy with the primary purpose of minimizing his vision both within and beyond his position area.

SCREEN MANEUVER ELEMENTS



OR

SCREENING — Smoke placed on the battlefield to deceive or confuse the enemy as to the activities of the maneuver elements.

Do not neglect the use of smoke at night. Enemy direct fire weapons, such as the Sagger, are equipped with night vision devices. Darkness can bring on a FALSE sense of security, which, on the modern battlefield can be fatal to the maneuver elements.

WHETHER USED IN OFFENSIVE OR DEFENSIVE OPERATIONS,
SMOKE CAN—

MINIMIZE VULNERABILITY

MAXIMIZE EFFECTIVENESS

b. *Obscure enemy vision.* Use smoke to:

(1) Defeat flash ranging; restrict the enemy's counterfire program.

(2) Obscure artillery OP's; reduce the accuracy of enemy observed fires.

(3) Obscure enemy direct fire weapons to include wire-guided missiles to reduce their effectiveness up to 90 percent.

(4) Obscure enemy lasers to reduce their effectiveness.

(5) Instill apprehension; increase enemy patrolling.

(6) Slow enemy vehicles to blackout speeds.

(7) Increase command and control problems; prevent effective visual signals and increase radio traffic.

(8) Defeat night observation devices and reduce the capability of most IR devices.

**MAXIMIZE YOUR EFFECTIVENESS
BY MINIMIZING THE ENEMY'S.**

c. Screen maneuver elements. Use smoke to screen:

(1) Unit maneuvers.

(a) Smoke draws fire. Insure that screens are large enough so that random enemy fire will not cause excessive casualties.

(b) Deceptive screens cause the enemy to disperse his fires and expend his ammunition.

(2) Flanks. Smoke may be used to screen exposed flanks.

(3) Areas forward of the objective. Smoke assists the maneuver units in consolidating on the objective.

(4) River-crossing operations. Screening the primary crossing site denies the enemy information, and deceptive screens deceive the enemy as to the exact location of the main crossing.

MINIMIZE YOUR VULNERABILITIES.

7-4. Smoke Ammunition and Delivery Means Available

a. Field artillery. Field artillery smoke ammunition consists of two types with different burning characteristics:

- (1) WP (white phosphorus).
- (2) HC (hexachloroethane).

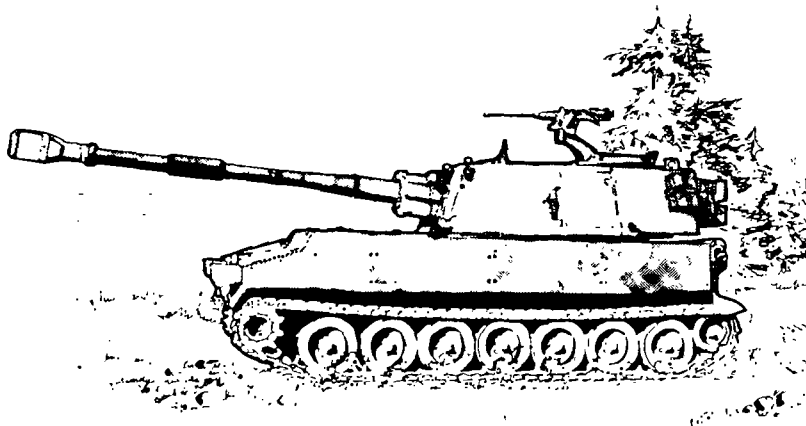
-KNOW YOUR SMOKE AMMUNITION-ITS CAPABILITIES AND LIMITATIONS.

b. Mortars. Mortars can provide good initial smoke coverage with WP ammunition because of their high rates of fire.

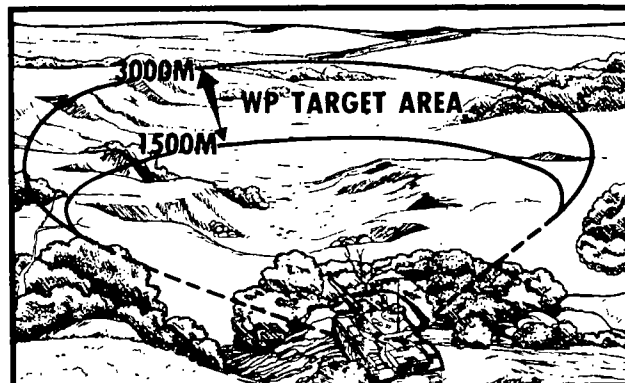
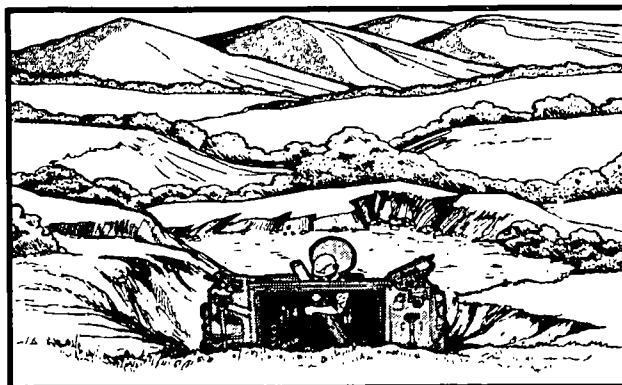
c. Tanks. Tanks firing from overwatch positions can suppress antitank guided missile gunners at 1500-3000 meters with WP ammunition. The basic load for tanks in Europe includes some WP ammunition.

**KNOW WHAT THE MANEUVER UNIT
CAN PROVIDE IN SMOKE SUPPORT.**

Artillery Smoke Ammunition



Delivery System	Type Round	Nomenclature	Fuze	Time to Build Effective Smoke	Average Burning Time	Average Obscuration Length (Meters) Per Round		
						Wind Direction		
						Cross	Quartering	Head/Tail
155mm	WP	M110B2	M557	½min	1-1½ min	100	75	50
	HC	M116B1	M501A1	1-1½ min	4 min	350	250	75
105mm	WP	M60A1	M557	½ min	1-1½ min	75	60	50
	HC	M84B1	M501A1	1-1½ min	3 min	250	175	50



Maneuver Smoke Capability

Mortar Delivery System	Number/Bn	Sustained Rate of Fire	Type Round	Time to Build Effective Smoke	Average Burning Time	Average Obscuration Length (Meters)		
						Per Round		
						Wind Direction		
						Cross	Quartering	Head/Tail
4.2-inch*	4	3 Rds/min	WP	½ min	1 min	200	80	40
81mm	9	8 Rds/min	WP	½ min	1 min	100	60	40

*The 4.2-inch mortar is a better smoker than the 105mm howitzer firing WP.

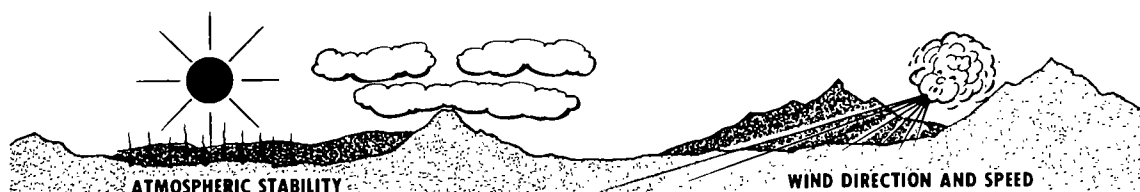
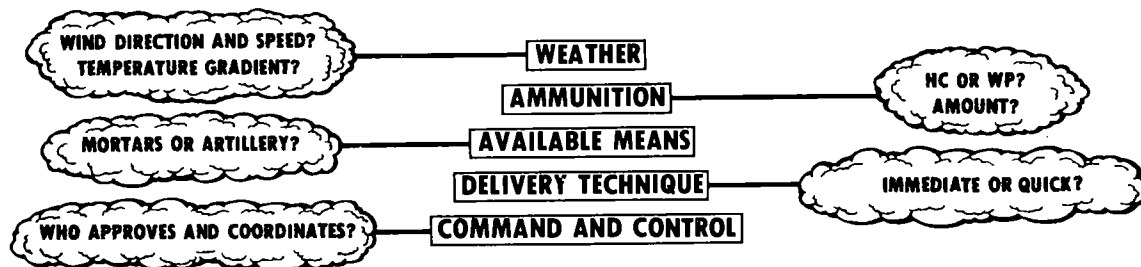
7-5. Employment Considerations

a. *Weather.* The FO is the normal source of wind and smoke condition data for the target area; he determines the data based on what he sees and feels. Atmospheric stability, wind direction, and wind speed are the major factors influencing the effectiveness of smoke.

(1) Atmospheric stability. The weather conditions, the time of day, and the wind speed all affect atmospheric stability. The atmospheric stability is categorized into three temperature gradients--inversion

(stable), neutral, and lapse (unstable). The temperature gradient is an expression of the difference in air temperature from one-half meter to 4 meters above the ground. Vertical variations in temperature affect air stability, which in turn affects the formation of vertical air currents.

FOR ALL FIELD ARTILLERY SMOKE MISSIONS, THE TERMS IDEAL, FAVORABLE, AND MARGINAL WILL BE USED TO DESCRIBE THE SMOKE CONDITION.



Smoke Employment Considerations

WIND SPEED?
WIND DIRECTION?
CLOUDS?
TIME OF DAY?



GENERAL ATMOSPHERIC CONDITIONS AND EFFECT ON SMOKE

SMOKE CONDITION (Temperature Gradient)*	Time of Day Weather Conditions	Expected Smoke Behavior as the Smoke Drifts Downwind. (Wind Direction -----)
IDEAL (Inversion)	1. NIGHT - until 1 hour after sunrise. 2. Wind speed less than 5 knots. 3. Sky cover less than 30 percent. ALL THREE CONDITIONS MUST BE MET.	 Stable condition - Ideal for smoke employment.
FAVORABLE (Neutral)	If not Ideal or Marginal. This condition will occur most often 1-2 hours before and after sunrise and whenever the wind speed is 5 knots or more and/or the sky cover is 30 percent or more.	 Neutral condition - Favorable for smoke employment.
MARGINAL (Lapse)	1. DAY - beginning at 2 hours after sunrise. 2. Wind speed less than 5 knots. 3. Sky cover less than 30 percent. ALL THREE CONDITIONS MUST BE MET.	 Unstable condition - Marginal for smoke employment.

*The terms *IDEAL*, *FAVORABLE*, and *MARGINAL* were chosen to closely correspond to required ammunition expenditures. Normally, the inversion temperature gradient results in less ammunition expenditure than either the neutral or lapse condition and, therefore is, in fact, the *IDEAL* smoke condition. Similarly, the neutral condition requires less ammunition be expended than under lapse conditions and is therefore considered *FAVORABLE* for the employment of smoke.

(2) Wind direction and speed. The movement of smoke depends on the speed and direction of the wind.

(a) Wind speeds ranging from 4 to 14 knots are best for the production of smoke screens. Optimum speeds vary with the type of smoke used.

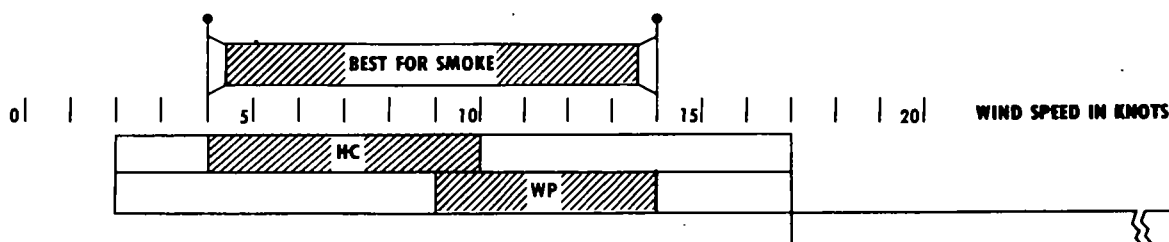
(b) Wind direction influences the desired location of smoke in the impact area.

(3) Other considerations.

(a) Temperature. A rise in temperature may increase the rate of evaporation, causing the smokescreen to dissipate more rapidly.

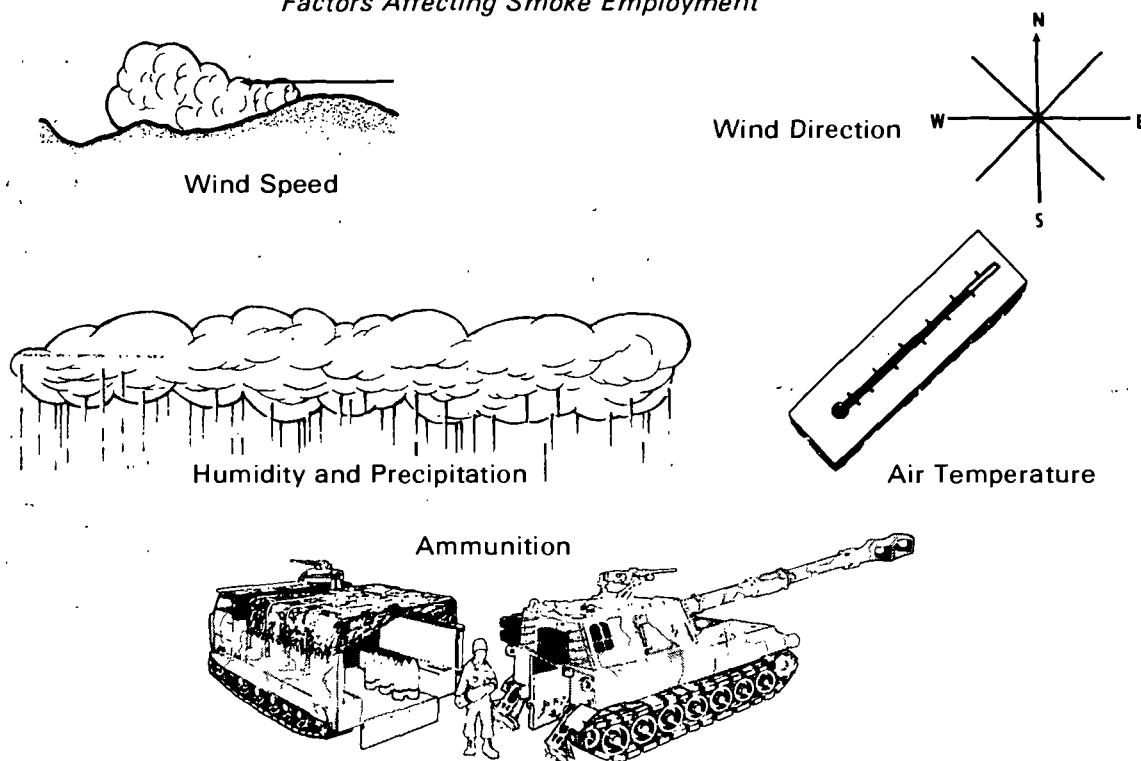
(b) Humidity and precipitation. Humidity and precipitation may enhance the effectiveness of smoke.

b. *Ammunition.* The amount of smoke ammunition in basic loads is limited. Expenditures of smoke ammunition vary considerably with each specific mission. All users, especially the FO, FDO, and FSO, must know the amount of ammunition available and how much smoke it will provide. Large requirements for smoke may require redistribution of the basic loads of several units or issue of additional smoke ammunition for a specific operation. Combat experience has shown that smoke ammunition will not be available to support all smoke requests.



Suitable Wind Speeds for Smoke Employment

Factors Affecting Smoke Employment



THINK AHEAD — PRESTOCK SMOKE WHEN THE SITUATION DEMANDS.

c. *Available means.* Prior to firing a smoke mission, the FO, FDO, and FSO must consider the means available. The FO recommends to the maneuver commander whether mortars or artillery should fire. The FDO decides which artillery weapons will fire or whether to have a reinforcing unit, if available, support the mission. The FSO provides tactical information which could affect the fire support available. Remember, all assets are limited and for each mission the decision

must be made: **WHO CAN BEST FULFILL THE REQUIREMENTS?**

d. *Delivery techniques.* Using different amounts of smoke on the battlefield against targets of various sizes requires different gunnery techniques. The use of the two delivery techniques outlined below does not preclude the use of smoke on other occasions or for different objectives (see appendix F for discussion of special smoke missions). The

Table 7-1. Smoke delivery techniques

DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Immediate Smoke * (Point/Suppression)	Point or small area 150M or less	1 Plt ** (2 Guns)	1st Rd's WP, HC 2d Rd's HC	Parallel or terrain gun position corrections	½ - 5 min	By SOP and/or approval of maneuver company commander
Quick Smoke (Small Area/Suppression)	Small area 150 to 600M ***	1-2-3 Plt **	HC or WP	Parallel or terrain gun position corrections	4-15 min	Approval of maneuver battalion commander

* The immediate smoke technique can be used in an immediate suppression mission on a target of opportunity; by unit SOP, a mix of WP and HC normally will follow the initial suppression rounds when immediate smoke is requested.

** Responsiveness dictates that both immediate and quick smoke missions be fired by platoon.

*** For larger areas, consider multiple aimpoints using the quick smoke technique.

objective of the two prescribed techniques is to obscure the enemy's vision or screen the maneuver element. The differences between delivery techniques are outlined in table 7-1.

e. Command and control. The maneuver commander for whom the smoke is planned must approve its employment. When he issues his plans and concepts for an operation, he should state the guidelines on the amount of smoke that can be used, along with any restriction on its use. To insure that smoke is responsive, the FO, FSO, and/or FSCOORD must request this smoke planning guidance if it has not been stated.

(1) The maneuver commander responsible for the operation must coordinate smoke operations with all units participating in or potentially affected by the operation.

(2) The operations officer (S3/G3) is responsible for the integration of smoke into the plan of maneuver.

(3) The FSO/FSCOORD must keep the maneuver commander advised on the availability of munitions and delivery systems.

(4) Combat arms troops must be well trained in smoke operations and comprehensive SOP's must be available and known to all. This will shorten reaction time.

7-6. FO Tactical Considerations

THE KEY TO SUCCESSFUL EMPLOYMENT OF ARTILLERY SMOKE IS THE FORWARD OBSERVER.

a. Be in a position to observe.

(1) If smoked by the enemy:

(a) Move to higher ground.

(b) Move upwind.

(2) Use battlefield illumination or night vision devices when employing smoke at night.



**TO ACCOMPLISH YOUR MISSION,
YOU MUST BE ABLE TO OBSERVE**

b. Know the terrain. The terrain affects the employment of smoke.

(1) Smoke tanks in defile; they lose their sense of direction.

(2) Remember that smoke seeks low spots.



(3) Remember that firing smoke on dry vegetation may start fires.

(4) Do not fire smoke on deep mud, water, or snow; the smoke round normally will not function properly.

(5) Do not fire HC on steep slopes; canisters roll downhill.

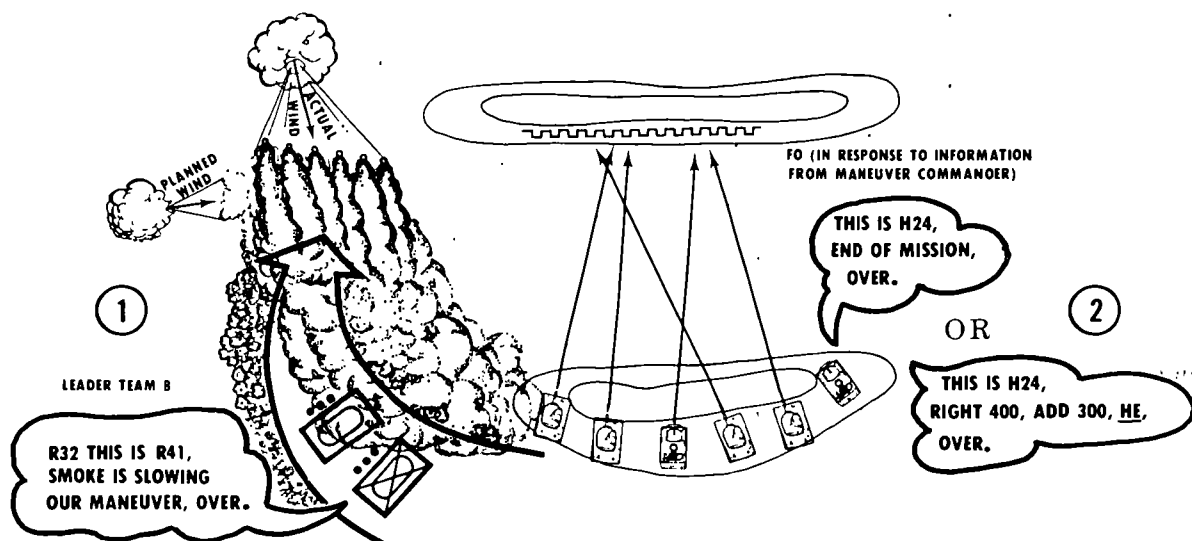


c. Be flexible.

(1) Remember that smoke does not always have to be placed on or in front of the enemy's frontline elements to be effective. Smoke can be placed behind these elements to silhouette them or to obscure the enemy's vision from overwatch positions.

(2) Firing of smoke by an aerial observer may be more difficult since he may not always be in a position to adequately determine the smoke conditions or to insure that the smoke is effective.

(3) Be ready to make changes if the smoke begins to hamper maneuver elements.



Have an Alternate Plan and Means Available Should Weather Conditions Make the Smoke Ineffective or Interfere with Maneuver Plans.

d. *Know the artillery's smoke capability. You should know:*

- (1) The amount of smoke ammunition available.
- (2) The approximate number of rounds required for a battery to provide a smokescreen of a given size with various wind speeds, wind directions, and atmospheric conditions.

Approximate number of smoke rounds required = factor × rate of fire × duration of screen × screen length ÷ 100.

FACTORS FOR DETERMINING EFFECTIVE OBSCURATION LENGTH
PER 100 METERS OF SCREEN

WIND DIRECTION	105mm		155mm	
	NC	WP	NC	WP
Cross	0.40	1.30	0.29	1.00
Quartering	0.57	1.67	0.40	1.30
Head or Tail	2.00	2.00	1.30	2.00

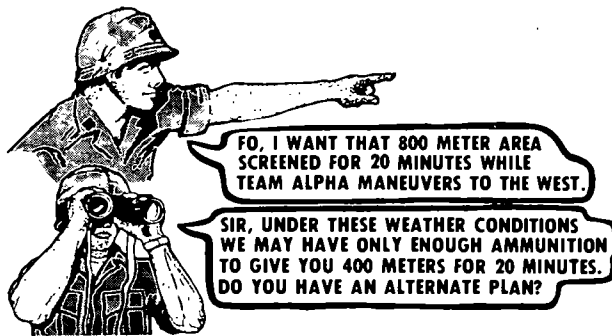
Number of Guns = Factor X Screen Length ÷ 100.

RATE OF FIRE TABLE

SMOKE CONDITIONS	WIND SPEED IN KNOTS	ROUNDS PER MINUTE			
		105mm		155mm	
		NC	WP	NC	WP
Ideal	5	1	1½	½	½
Favorable	5	1	2	½	1
	10	2	4	1	2
	15	2½	6	1½	3
Marginal	5	3	•	1½	•

* Under these conditions the number of rounds exceeds the rate of fire for the weapon.

(3) THE MANEUVER COMMANDER MUST KNOW YOUR CAPABILITY TO PROVIDE THE REQUESTED SUPPORT DURING THE PLANNING PHASE OF THE OPERATION - NOT AFTER THE PLANNING PHASE HAS BEEN COMPLETED.



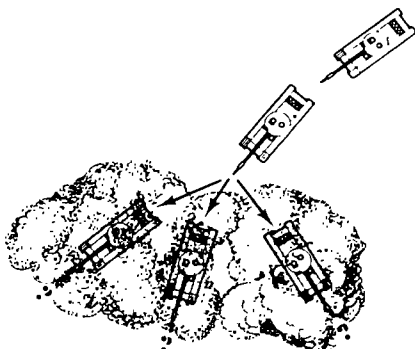
THE ACTUAL AMOUNT OF SMOKE AMMUNITION REQUIRED TO MAINTAIN A SMOKESCREEN MUST BE DETERMINED BY OBSERVATION.

e. Know and anticipate the enemy.

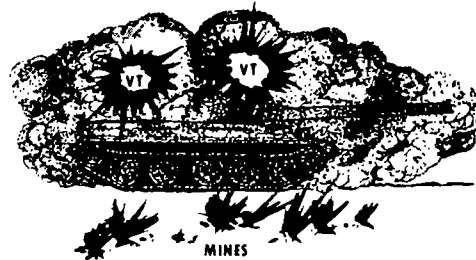
(1) Fire smoke on enemy artillery OP's/ FDC's to greatly reduce the effectiveness of his artillery.



(2) Fire smoke and HE on the enemy when he deploys from column to line formation. The HE will keep him buttoned up. The smoke will cause maximum confusion.



(3) Fire smoke and HE on minefields to cause maximum confusion. The enemy will not know what he is being hit with.



f. Understand the effects of smoke on effectiveness. Smoke used without sufficient thought and planning will reduce your effectiveness more than that of the enemy.

g. Compensate for reduced effectiveness of smoke. A gap in the smokescreen can develop as a result of a faulty sheaf or faulty ammunition.



DO NOT LET THE MANEUVER UNIT GET CAUGHT IN THE OPEN.

7-7. Weather Considerations

a. Determine wind speed and direction.

(1) Wind speed. Use either the equivalent wind scale table or the grass drop (expedient) method.

(a) Equivalent wind scale table.

EQUIVALENT WIND SCALE TABLE

KNOTS	OBSERVATION
1	Smoke, vapor from breath, or dust raised by vehicles or personnel rises vertically/no leaf movement.
1-3	Direction of wind slightly shown by smoke, vapor from breath, or dust raised by vehicles or personnel. Slight intermittent movement of leaves.
4-6	Wind slightly felt on face/leaves rustle.
7-10	Leaves and small twigs in constant motion.
11-16	Wind raises dust from ground/loose paper and small branches move.
17-21	Small trees with leaves sway/coastal wavelets form on inland waters.
22-27	Large branches on trees in motion/whistle heard in telephone or fence wires.
28-33	Whole trees in motion/inconvenience felt walking against wind.

(b) Grass drop (expedient) method. Extend arm downwind and drop grass from hand. Point extended arm at dropped grass on ground. Divide the angle in degrees between the arm and the body by 4 to determine the approximate wind velocity in knots.

(2) Wind direction. Observe:

- (a) Drifting of smoke or dust.
- (b) Bending of grass or trees.
- (c) Ripples on water.

(3) Determine the wind direction in relation to the maneuver-target line for obscuration. You need only determine the wind direction in terms of:

- (a) Crosswind.
- (b) Quartering wind.
- (c) Tailwind/Headwind.

THIS IS H24, REQUEST SMOKE CONDITION AND WIND SPEED, THE WEATHER IS HEAVY OVERCAST, WIND RAISES DUST FROM GROUND, OVER.

FO

THIS IS H18, SMOKE CONDITION FAVORABLE, WIND SPEED 15 KNOTS, OVER.

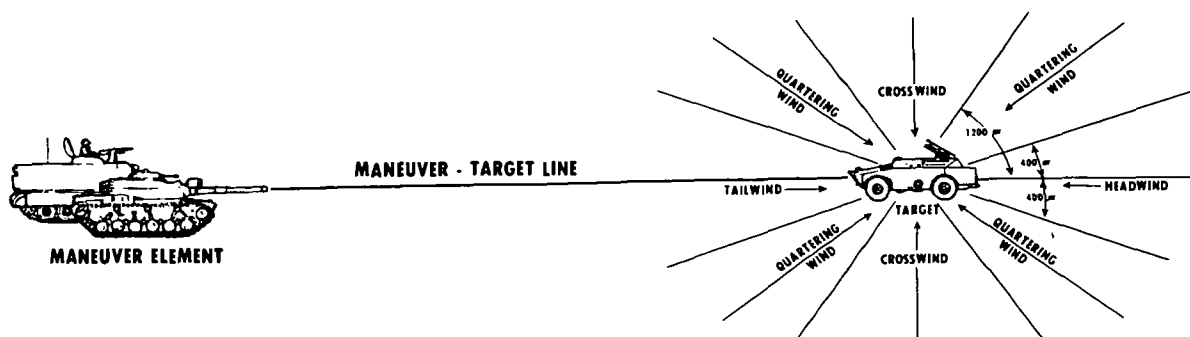
FDC

7-8. FO Smoke Delivery Techniques

a. Immediate smoke.

(1) Objective. The objective of immediate smoke is to obscure the enemy's vision.

(2) When to employ immediate smoke.



Determining Wind Direction

b. Determine smoke conditions (Ideal, Favorable, or Marginal). If you do not remember the smoke condition terms and cannot determine the wind speed, report the weather conditions as you see them to the FDC. The FDC will make the determination.

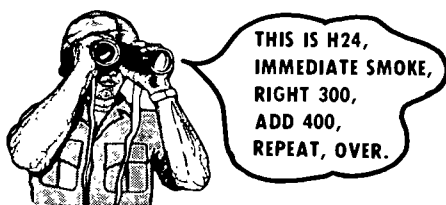
Suppression of a small location can be achieved by use of immediate smoke to reduce the enemy's ability to observe. Immediate smoke can be planned, as other planned suppressive fires, or can be used after immediate suppressive fire has been found to be ineffec-

DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Immediate Smoke * (Point/Suppression)	Point or small area 150M or less	1 Plt (2 Guns)	1st Rd's WP-HC 2d Rd's HC	Parallel or terrain gun position corrections	1/2 - 5 min	By SOP and/or approval of maneuver company commander

* The immediate smoke technique can be used in an immediate suppression mission on a target of opportunity; by unit SOP, a mix of WP and HC will normally follow the initial suppression rounds when immediate smoke is requested.

Immediate Smoke

tive. When immediate smoke is planned, the immediate smoke target will be sent to the FDC as part of the target list. Weather conditions must be considered in planning immediate smoke, since a change in wind direction could make the planned smoke ineffective. If immediate suppressive fire is ineffective because of inaccurate target location, you have the option of giving a bold shift and requesting that the smoke be fired.



Immediate HC smoke may be effective downwind 1100 meters or more.

(3) Employment considerations. Immediate smoke should not be requested initially if HE is in the loading tray by SOP. Rather than change the ammunition, you should request a fire mission that will expend the SOP suppression rounds (use them as adjusting rounds) and then call for immediate smoke. Before firing immediate smoke, you must consider:

- (a) Where the smoke should be placed.
- (b) That suppression by smoke will not be as immediate as suppression by HE since

it takes time for the smoke to build up.

(c) That inaccurately placed smoke may still provide obscuration, whereas inaccurately placed HE against a hard target or pinpoint target may not achieve the desired results.

(d) That immediate smoke will provide suppression (by obscuration) for a longer period of time than HE will.

(e) That approval by the supported company commander must be obtained by the observer to fire immediate smoke. (This approval may be given in the form of a general approval for a given phase of the operation.)

(f) That immediate smoke is effective only against a pinpoint target or small area target less than 150 meters in diameter.

(4) How to use immediate smoke.

(a) Ammunition. The type of ammunition to be fired should be dictated by SOP. A suggested mix is one platoon with one gun firing WP (for quick buildup) and with the other gun firing HC, followed by both guns firing HC.

(b) Adjustment. Since immediate smoke normally is used on a planned suppressive target or when shifting after immediate suppression with HE or ICM has been

Shift After Immediate Suppression

Initial Request

THIS IS H24, IMMEDIATE SUPPRESSION, GRID 946171, OVER.

DIRECTION 430, OVER.

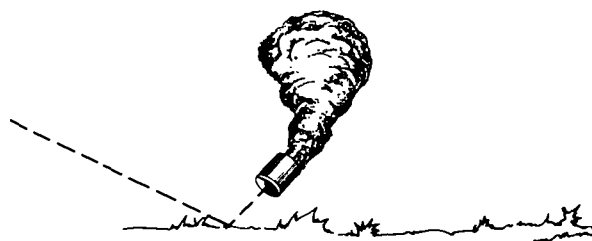
After HE Rounds Impact

THIS IS H24, IMMEDIATE SMOKE, RIGHT 100, DROP 200, REPEAT, OVER.

found to be ineffective, no adjustment is required prior to firing the smoke. If the smoke is ineffective because of positioning, then corrections for deviation, range and height of burst must be made. The minimum correction for deviation should be 50 meters and that for range should be 100 meters. The height of burst can be adjusted as follows:

- Ground burst: UP 100.
- Canisters bouncing: UP 50.
- Canisters too spread out: DOWN 50.

THIS IS H24, UP 50,
REPEAT, OVER.



(c) Duration. When a mixture of HC and WP is fired, it can be expected that the smoke will be effective 30 seconds after the

shells land and that it will last approximately 4-5 minutes. If the smoke is required for a longer period of time, request additional volleys of HC.

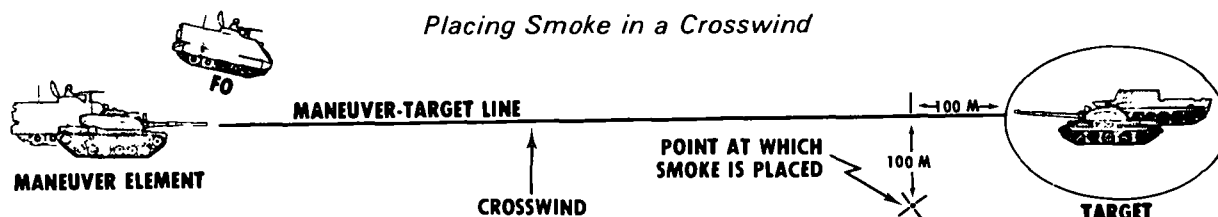
(5) Placement of immediate smoke. The point at which the smoke is placed depends on weather conditions. The smoke should be placed upwind so that it obscures the enemy's vision along the maneuver-target line. Under normal circumstances, the point at which it is directed should be approximately 100 meters short on the maneuver-target line and 100 meters upwind of the enemy location.

If the wind is a:

(a) Quatering wind, place the smoke the same as for a crosswind.

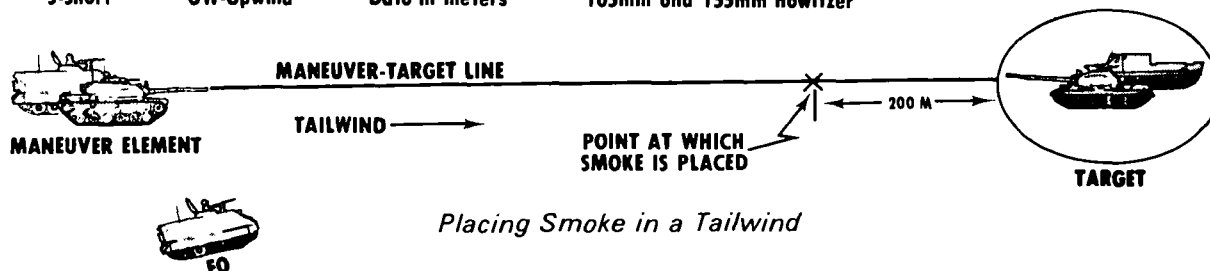
(b) Headwind (blowing away from the target), place the smoke 100 meters short on the maneuver-target line. **CARE MUST BE USED WITH HEADWINDS, SINCE THE SMOKE MAY BE BLOWN ONTO THE MANEUVER ELEMENT.**

(c) Tailwind (blowing toward the target), place the smoke at least 200 meters short of the target to preclude the smoke from landing beyond the target.



Adjusting Points for Immediate Smoke

Delivery Technique	Wind Direction				Adjusting Point With Respect to:
	Cross	Quartering	Head	Tail	
Immediate (WP & HC) Point/Suppression	100S-100UW	100S-100UW	100S	200S	Point to obscure on MT line
S-Short	UW-Upwind	Data in meters		105mm and 155mm howitzer	



b. Quick smoke.

(1) Objective. The objective of quick smoke is to obscure the enemy's vision or screen maneuver elements.

Example 1. FO fires a quick smoke mission, observes effects, and announces to FDC:

SECOND AIMPOINT, RIGHT 500,
DROP 200, REPEAT, OVER.*

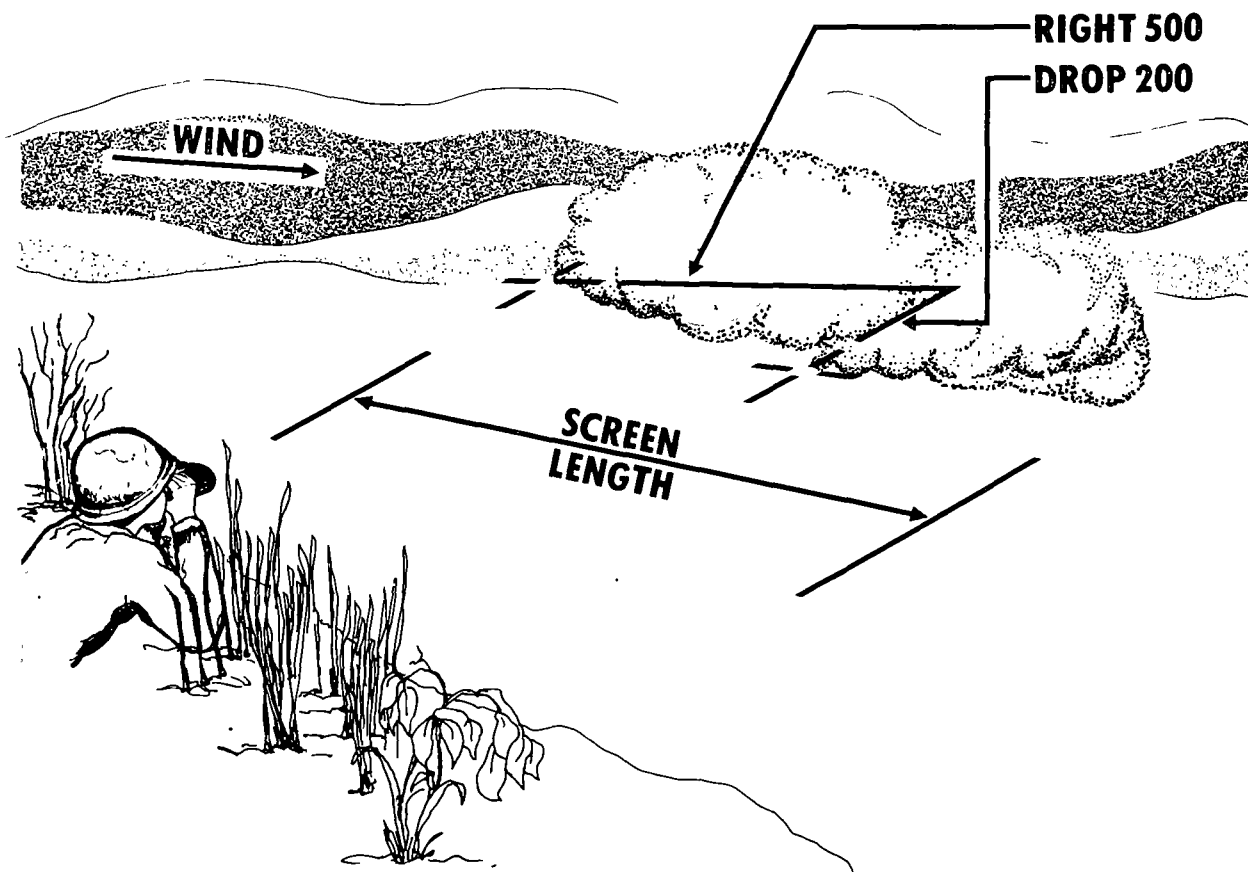
DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Quick Smoke (Small Area/Suppression)	Small area 150 to 600M	1-2-3 Plt	HC or WP	Parallel or terrain gun position corrections	4-15 min	Approval of maneuver battalion commander

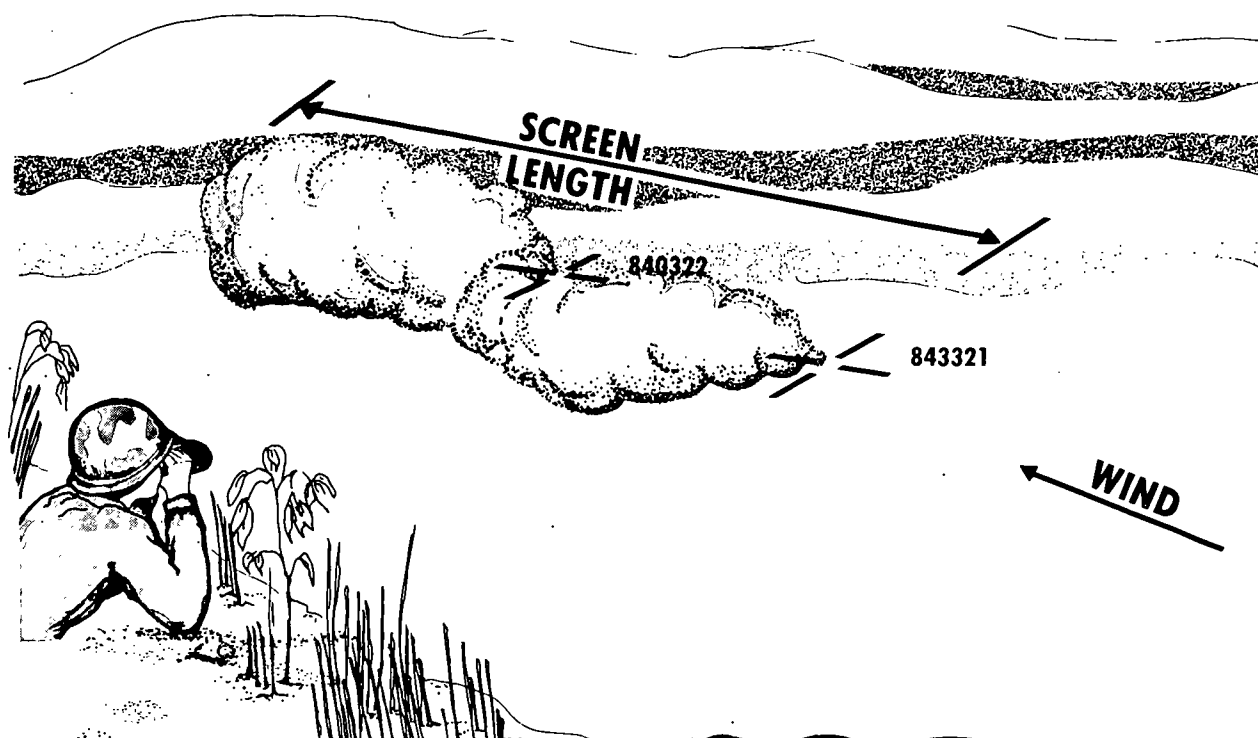
(2) When to employ quick smoke. The quick smoke mission equates to the normal HE adjust fire mission; obscuring the enemy is required, but the urgency of the situation does not dictate immediate smoke procedures. The quick smoke mission is used to obscure an area target up to 600 meters in width; *FOR OBSCURATION OF MORE THAN 600 METERS, THE OBSERVER CAN FIRE MULTIPLE QUICK SMOKE MISSIONS AT DIFFERENT AIMPOINTS.*

*Had the FO simply desired to move the quick smoke to another point, he would have made a normal subsequent correction and said:

RIGHT 500, DROP 200, REPEAT, OVER.

SECOND AIMPOINT (or a local SOP term) informs the FDC that the FO desires to fire on a second point at this time and that the battery should be prepared to replenish smoke on





either point. By observing how long the smoke remains effective near either aimpoint, the FO can determine a time interval at which to replenish his smoke should he desire to do so.

**INTERVAL = EFFECTIVE SCREEN
TIME — BUILDUP TIME**

He can pass this information to the FDC by saying:

**CONTINUE SMOKE AT 3 MINUTE
INTERVALS FOR 15 MINUTES, OVER.**

Example 2. FO calls for multiple aimpoints at the beginning of the mission.

-Approval of the maneuver battalion commander.

-Duration required.

-Location of the area to be obscured or screened.

-Ammunition available.

**H18 THIS IS H24, FIRE FOR EFFECT,
QUICK SMOKE, OVER.**

**GRID 843321, 2 PLATOONS, GRID
840322, 1 PLATOON, HC, OVER.**

Note. If positioning of individual rounds is of prime consideration and weapons and ammunition have been dedicated to provide smoke for an extended period of time, then procedures in Appendix F might be considered.

**QUICK HC SMOKE MAY BE EFFEC-
TIVE 1500 METERS OR MORE
DOWNWIND.**

(3) Employment considerations. Prior to firing a quick smoke mission, take the following factors into consideration:

-Alternative should the smoke be ineffective.

-Time to be effective.

-Means available.

-Weather conditions.

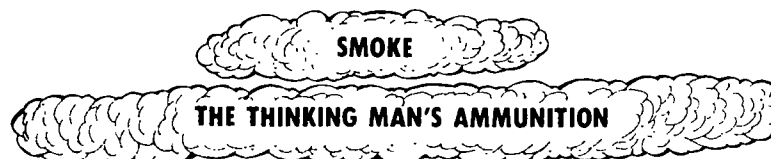


TABLE OF QUICK SMOKE DATA *

Weapon/Ammo		Width of Target to be Obscured in Meters								
		Wind Direction **								
		Cross			Quartering			Head/Tail		
155mm	HC	400	500	600	300	400	500	100	200	300
	WP ***	200	300	400	150	250	350	100	200	300
105mm	HC	300	400	500	200	300	400	100	200	300
	WP ***	100	200	300	100	200	300	100	200	300
Platoons to Fire		1 Plt	2 Plt's	3 Plt's	1 Plt	2 Plt's	3 Plt's	1 Plt	2 Plt's	3 Plt's

* For planning purposes using a normal battery front or with terrain position corrections applied.

** The wind direction is with reference to the maneuver-target line.

*** For WP, there must be a wind of at least 10 knots.

(4) Planning for quick smoke. In order to plan for the quick smoke:

(a) Determine the size of the area to be obscured or screened.

(b) Determine the number of platoons to fire. Since there normally is not sufficient time to send the necessary weather conditions and target description to the FDC, the FO must decide whether the screen can be fired and the number of platoons required.

Be familiar with the table of quick smoke data to determine the number of platoons to fire.

(5) Placement of quick smoke. In order to select the HE adjusting point, you need to determine the wind direction and whether WP or HC is to be fired in effect. Assuming a center gun adjusting, the following table can be used to determine the adjusting point from the *CENTER* of the area to be obscured or screened.

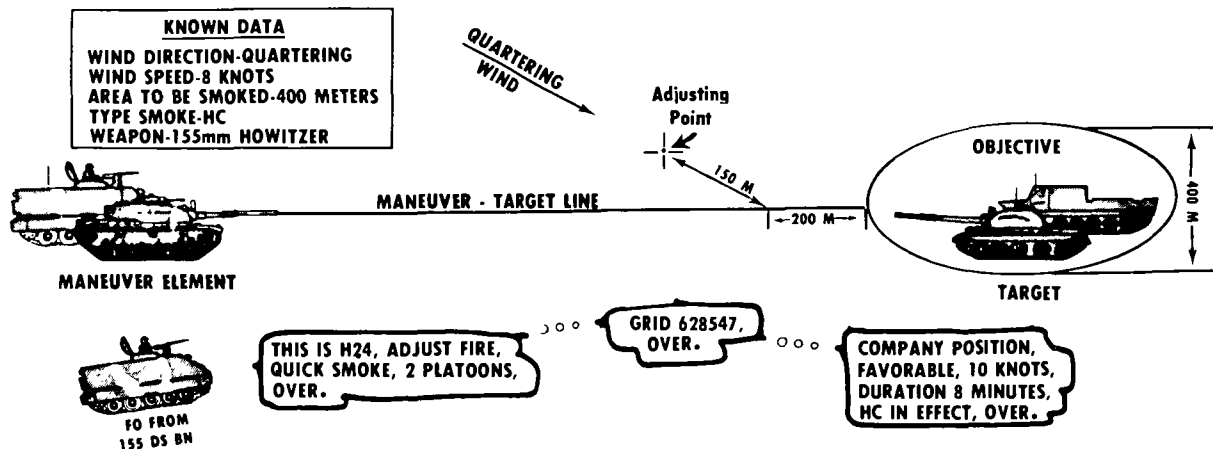
Delivery Technique		Wind Direction				Adjusting Point With Respect to:
		Cross	Quartering	Head	Tail	
Quick (Small area/Suppression)	WP	200S-150UW	200S-75UW	100S	200S	Area to be obscured or screened on MT line
	HC	200S-200UW	200S-150UW	100S	400S	

S-Short UW-Upwind

Distance in meters

105mm and 155mm howitzer

Adjustment of Smoke with a Quartering Wind



(6) Fire for effect.

(a) The approval of the maneuver battalion commander must be obtained before the smoke is fired in effect; this should not, however, hold up the adjustment with HE. This approval can take the form of a general approval for a given operation.

(b) If the smoke is required for an extended period of time (more than 2 minutes for WP and 5 minutes for HC), inform the FDC of the wind speed, the smoke condition, and the length of time the smoke is required. Send this information to the FDC as early as possible (prior to commanding FIRE FOR EFFECT). You also have the option of ex-

tending the time of effective smoke by requesting subsequent volleys.

(c) If you want the smoke to be effective beginning at a specific time, request *AT MY COMMAND* and the time of flight. To determine when to order the smoke fired, add the time of flight to the average buildup time of 30 seconds for WP and 60 seconds for HC.

(d) If the smoke is ineffective, decide on whether to shift the smoke or fire HE. If you decide to shift, remember that there may be a break in the screen while new data are being computed.

SHIFT THE SMOKE

THIS IS H24, LEFT 200,
ADD 100, REPEAT, OVER.

OR

FIRE HE

THIS IS H24, HE, LEFT 100
ADD 300, REPEAT, OVER.

Section III. COUNTERFIRE

7-9. General

Counterfire will be initiated either in response to a request for immediate counterfire or against lucrative/fleeting counterfire targets of opportunity. Planned counterfire programs will be initiated to suppress the enemy's artillery at the critical time and place. The forward observer plays an important role in counterfire both as a source of target information and the initiator of requests for immediate counterfire in support of his maneuver force.

7-10. Counterfire Target Information

As one of the eyes of the artillery, the observer must forward the following informa-

tion (whenever observed) to his FDC or FSCC as expeditiously as possible. Local SOP's will specify who should be called and what actions should be taken by the person receiving the request.

a. Locations of enemy indirect fire weapons and command observation posts (COP).

b. Counterfire damage assessments.

7-11. Immediate Counterfire

Any unit receiving incoming artillery, mortar or rocket fire can request immediate counterfire from the field artillery. Requests should include:

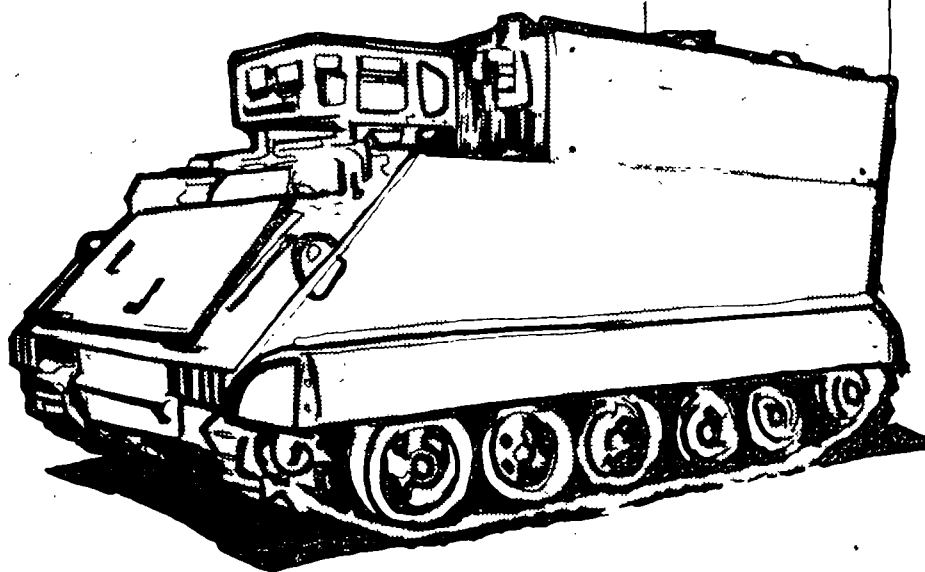
Identification	→	T2B56 THIS IS X2F71,
Warning order	→	IMMEDIATE COUNTERFIRE, OVER.
Type of fire	→	HEAVY MORTARS,
Direction of source of fire	→	FROM NORTHWEST,
Severity of fire	→	RECEIVED 10-20 ROUNDS AND STILL UNDER FIRE,
Area shelled (grid)	→	AB147638 (ENCODED BEFORE TRANSMITTING), OVER.

Maneuver and artillery units request counterfire through normal fire support/fire direction channels. Requests for immediate counterfire can be transmitted in clear text;

however, the coordinates of the area shelled should be encoded to prevent the enemy from determining the effectiveness of his fires.

PART FOUR

FIRE DIRECTION



CHAPTER 8

FIRE DIRECTION, GENERAL

CHAPTER 8

FIRE DIRECTION, GENERAL

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8-11	Graphical Firing Tables (GFT's)	8-4
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8-1. Definitions

a. Tactical fire direction. Tactical fire direction is the exercise of tactical command of one or more units in the:

- (1) Selection of targets.
- (2) Designation of units to fire.
- (3) Allocation of ammunition for each mission.

b. Technical fire direction. Technical fire direction is the conversion of calls for fire to appropriate firing data and fire commands.

8-2. Objectives of Fire Direction

The objectives of fire direction are:

- a.* Continuous, accurate, and responsive fire support under all conditions of weather, visibility, and terrain.
- b.* Flexibility to engage all types of targets over a wide area.
- c.* Prompt massing of fires of all available units in any area within range of the units.
- d.* Prompt distribution of fires simultaneously on numerous targets within range.

8-3. Scope

This chapter is concerned primarily with technical fire direction for field artillery cannon batteries and battalions. For a discussion of tactical fire direction, see FM 6-20.

8-4. Role of the Fire Direction Center (FDC)

The FDC is the element of the gunnery team that:

- a.* Receives the call for fire from the observer.
- b.* Converts the call for fire to firing data.
- c.* Announces fire commands to the firing battery.

8-5. Principles of FDC Operation

Accuracy, flexibility, and speed in the execution of fire missions depend on:

- a.* Rapid, accurate preparation of firing data and transmission of fire commands.

b. Efficient use of FDC plotting equipment and data-determining devices.

c. Teamwork among FDC personnel.

d. Efficient use of communications equipment.

8-6. Fire Direction Responsibilities

The normal breakdown of responsibilities between the battery and battalion FDC's is presented in table 8-1.

Table 8-1. Fire direction responsibilities.

FDC Level	Tactical	Technical
Battery	Targets of opportunity Informal fire planning Request for additional fires	All firing data
Battalion	Formal fire planning Guidance to battery Decision on additional fires	Backup Required coordination for massed fires

8-7. Fire Planning

a. Informal fire planning is tied to the dynamics of the battlefield. Practically speaking, it goes from lower to higher and is done primarily at the maneuver company and battalion level.

(1) The FO will continuously plan targets to support the maneuver commander's battle plan, insuring that the maneuver leaders can identify the targets and associate them with a target number. He will send his targets to the battalion FSO. The FSO, in turn, will resolve any conflicts or duplication of targets before passing the targets to the DS battalion FDC. The FSO will notify the FO of any changes to his (FO's) target list.

(2) The battery that normally fires for the FO will:

- (a)* Monitor the communication between the FO and the FSO.
- (b)* Acknowledge the communication.
- (c)* Compute data.
- (d)* Record the target as an on-call.
- (e)* Monitor the FSO's communication to the DS battalion FDC to check for addi-

tions or deletions and acknowledge the transmission.

(3) The DS battalion FDC will call the battery concerning a target only if there is a change.

b. Formal fire planning deals with specific operations and results in a written fire support plan. Battalion, rather than battery, is involved in this type planning.

c. Fire planning with a dedicated battery (see chapter 11) will be slightly different. In this case planned targets are sent directly to the battery by the FO; the FSO and battalion FDC monitor.

8-8. Responsibility for Technical Fire Direction

Because of the great distances between units on the modern battlefield and the requirement for improved responsiveness, technical fire direction normally will be conducted by the battery FDC. The battalion FDC will continue to provide tactical fire direction and to monitor all fire nets and will serve as a technical fire direction backup as required; however, the tactical situation will dictate the exact relationship between battery and battalion FDC's. For example, in airborne units within an airhead, the battalion FDC may assume technical fire control responsibility. The battalion FDC will provide the battery FDO's with (updated) detailed guidance on the techniques for engaging targets. This detailed guidance should preclude the need for the battalion FDO to actively participate in most fire missions, except when necessary to mass the fires of the battalion. It is expected that there will be a great number of important/large targets on the modern battlefield. When such a target

appears, the battalion FDO must decide quickly whether to permit the adjusting battery to conduct the mission on its own, or whether to mass the fires of the battalion.

8-9. Basis for Corrections - General

There are three normal means of determining firing data. They are the:

a. Field Artillery Digital Automatic Computer (FADAC).

b. Graphical firing tables (GFT's).

c. GFT fan.

8-10. Field Artillery Digital Automatic Computer (FADAC)

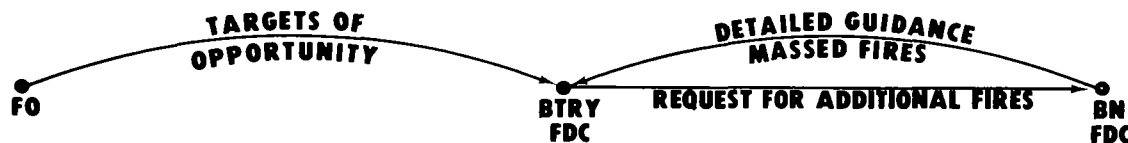
FADAC is the primary means of computing firing data. Use of this digital computer increases accuracy and flexibility in the delivery of artillery fires. FADAC's main limitation is in the area of responsiveness — it is relatively slow, requiring 2/3 the time of flight for initial computations.

8-11. Graphical Firing Tables (GFT's)

Graphical firing tables provide a simple means of quickly determining firing data. GFT's are used primarily for determining elevations and fuze settings for ranges determined from the firing chart.

8-12. GFT Fan

The GFT fan (fig 8-1) has been devised to shorten response times. A special multi-charge ballistic scale mounted on the arm of the normal RDP allows the chart operator to read elevation and fuze setting directly from the ballistic scale without first determining range. A well-trained operator can determine HE firing data consistently within 15 seconds after target location has been



FOR COUNTERFIRE TARGETS, OR FOR TARGETS THAT OBVIOUSLY WILL REQUIRE THE FIRES OF MORE THAN ONE BATTERY, THE FO SHOULD CONTACT THE BATTALION FDC DIRECTLY.

announced.

8-13. Corrections

Always use the best corrections available—these may be based on as little as a known

muzzle velocity or as much as a recently completed registration. Normally corrections will be based on FADAC or a FADAC-derived GFT setting (see chapter 12).

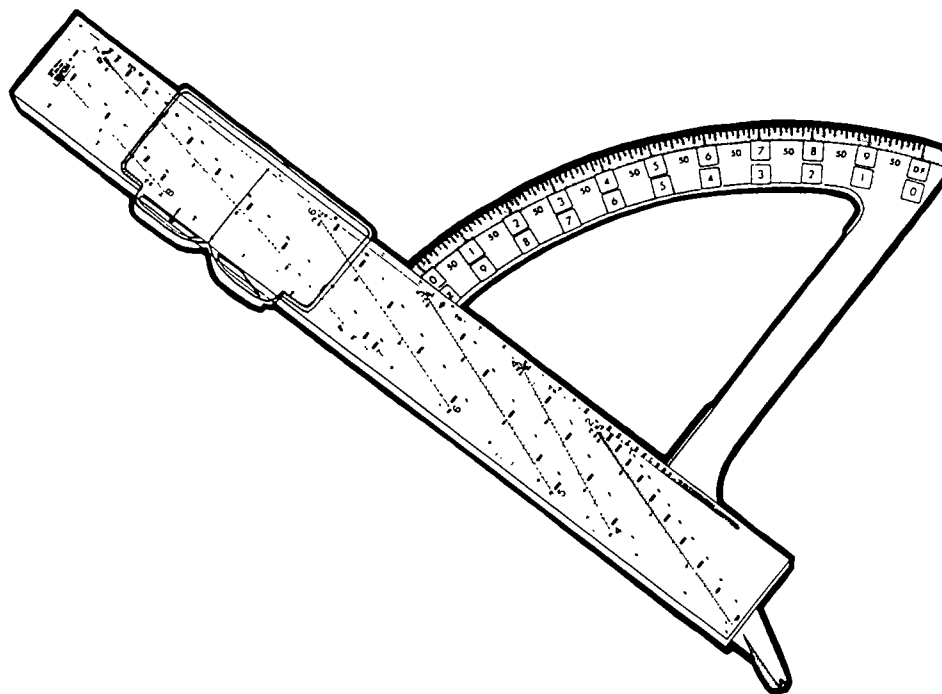


Figure 8-1. GFT fan.



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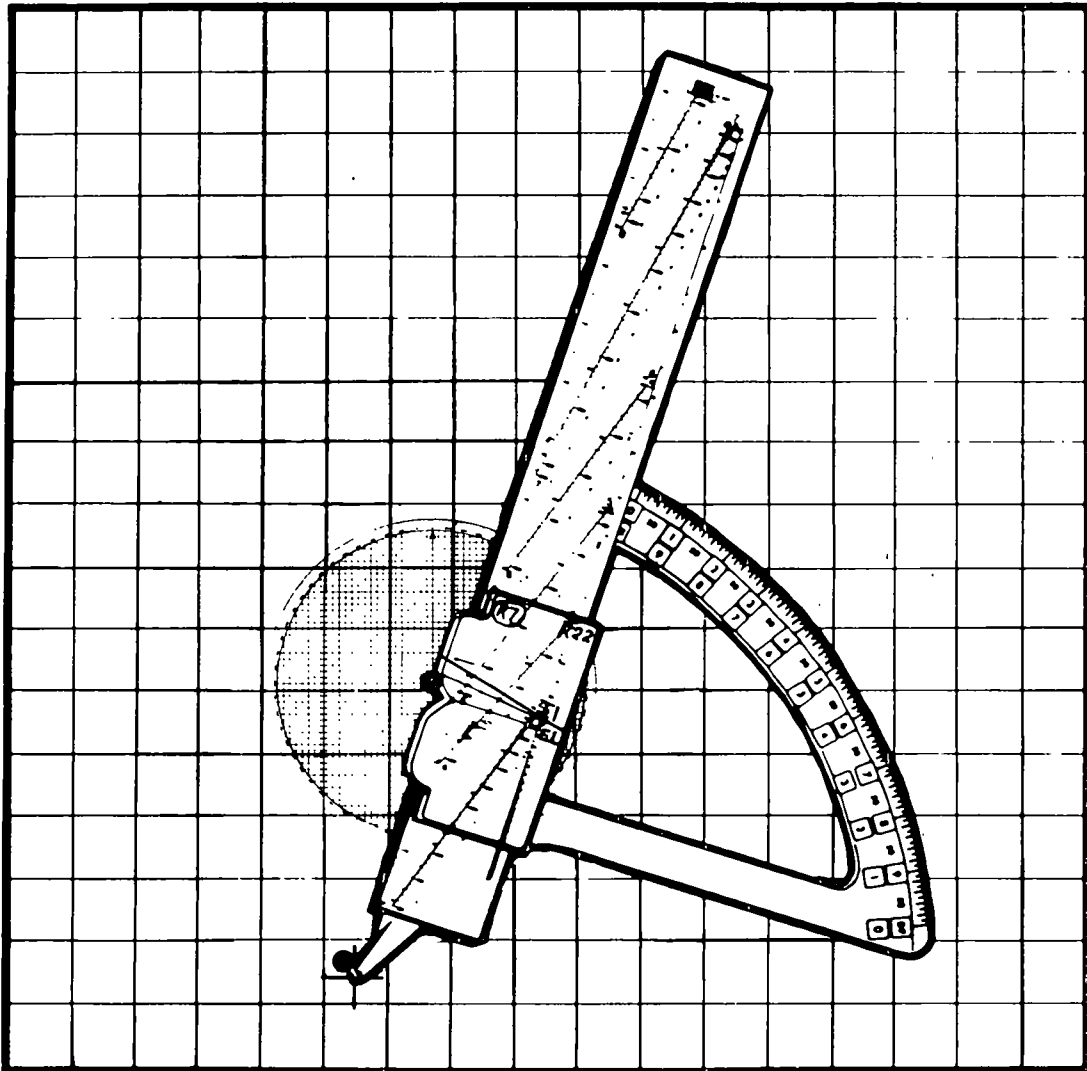
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CHAPTER 9

FIRE DIRECTION PROCEDURES



CHAPTER 9

FIRE DIRECTION PROCEDURES

Section I. BATTERY FDC PROCEDURES

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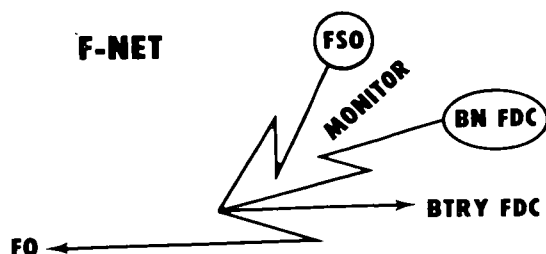
Section I. BATTERY FDC PROCEDURES

9-1. General

These procedures are designed to speed computation of firing data with minimal loss of accuracy. In applying any FDC procedures you must weigh the degree of urgency against the accuracy required, and use the most accurate procedures that time permits.

a. Fire mission. The battery FDC will normally answer calls for fire. Both the battalion FDC and the maneuver battalion FSO will monitor. Either may notify the battery FDC to modify the mission if necessary. Normally, their silence indicates concurrence. The battery FDO may request additional fires or the battalion FDO may step in and augment fires without a request.

Note. The FO can go directly to battalion if he needs to; e.g., counterfire.

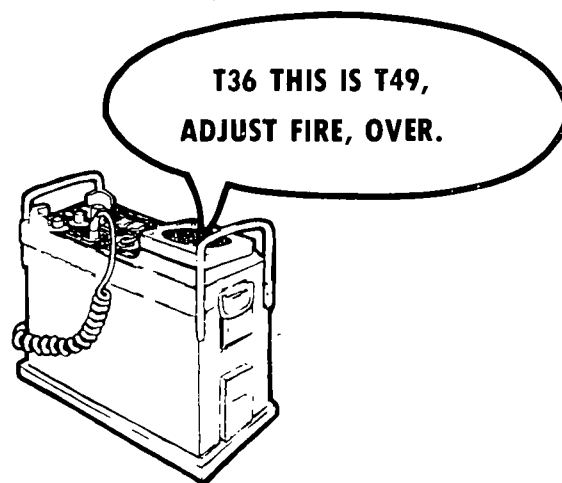


b. Maneuver progress monitored. Battalion FSO's must inform the supporting battery and battalion FDC's about maneuver unit progress. This information, supplemented by FO reports, will allow the FDC to anticipate and be more responsive to the fire support needs of the maneuver force. Another source of information is the maneuver command net. When the battle is hot, and responsiveness is critical, this net can be monitored by remoting the battery commander's/operation center's radio into the FDC.

c. Reorganized battery FDC. Elimination of the XO's post makes the battery FDC the center of all firing battery operations and expedites transmission of fire commands to the guns. For 24-hour operations, the XO and AXO must perform the duties of the FDO and share in the overall supervision of the firing battery on a shift basis. During critical situa-

tions the battery commander should be in the FDC to make tactical decisions.

d. Call for fire. It is advantageous for the call for fire to be heard by all members of the FDC. A remote loudspeaker capability can be obtained by using the AN/GRA-39.



9-2. Fire Order (General)

a. When a target is plotted, you should examine the plot. From your analysis of the target, decide whether the mission should be fired, and if so, how the target should be attacked.

b. If the mission is to be fired, issue the fire order, which informs the FDC of the manner in which the mission will be fired. To shorten and streamline the fire order, designate fire order standards. Standards will be established taking into consideration such things as command guidance, the current tactical situation and the ammunition available. **EVERY ELEMENT OF THE FIRE ORDER MUST BE ADDRESSED, EITHER IN THE ESTABLISHED FIRE ORDER STANDARDS OR IN THE VERBAL FIRE ORDER ISSUED BEFORE EACH MISSION.** Designate fire order standards only for those fire order elements that you predict will be used in the majority of your fire missions. **A CURRENT STANDARDS DISPLAY/CHART SHOULD BE POSTED IN THE FDC.** If an element of the fire order is not standardized, that portion on the display

will be left blank. The blank space will bring to your attention that the blank element must be addressed when you issue your fire order.

Note. Fire order standards will *not* "mix" adjust fire and fire for effect elements (e.g., "Quick in Adjustment, VT in Effect" as a standard fuze).

c. Before issuing the fire order, evaluate the call for fire and the existing fire order standards to determine what must be included in the fire order. By not announcing an element, you specify the standard for that element. If there is no standard, announce the element (i.e., silence *does not* mean agreement with the call for fire).

d. *THE COMPUTER WILL NOT RECEIVE ANY DIRECTIONS FROM THE OBSERVER'S CALL FOR FIRE. HE WILL BE GUIDED ENTIRELY BY ANY FIRE ORDER STANDARDS IN EXISTENCE AND THE FIRE ORDER ISSUED BY YOU.* He will always, however, record the call for fire unless engaged in another mission.

9-3. Fire Order Elements

THE TRADITIONAL STANDARD ELEMENTS OF A FIRE ORDER (CENTER ①, PARALLEL SHEAF, SHELL HE, FUZE QUICK, CENTER RANGE, CENTER DEFLECTION, WHEN READY) NO LONGER APPLY. The following elements must be addressed either in established standards or when the fire order is issued:

a. *Unit to fire.* The unit(s) that will follow the mission and fire in fire for effect.

b. *Adjusting element/method of fire of adjusting element.* The weapon(s) and method of fire that will be used if an adjustment is conducted. This element will either be "Fire for Effect" or a specified adjusting element and its method of fire (e.g., "NUMBER 3, ONE ROUND"). If you have standardized the ADJUSTING ELEMENT/METHOD OF FIRE OF ADJUSTING ELEMENT in anticipation of an adjust fire mission (e.g., "NUMBER 3, ONE ROUND") and wish to FFE, announce "FIRE FOR EFFECT." If "Fire for Effect" is the standard and you wish to conduct an adjustment, an-

nounce "ADJUST FIRE," followed by the adjusting element and its method of fire (e.g., "ADJUST FIRE, NUMBER 3, ONE ROUND").

c. *Basis for corrections.* The source of firing data. The standard for this element will normally be "Fastest Method." An FDC should begin computing data simultaneously with FADAC and a manual method (GFT fan, if available). Whichever method yields the most rapid solution (normally GFT fan with the first round, FADAC with the subsequent rounds) should be used as the source of firing data. FADAC should be used, if available, for computing data for planned targets, registrations, or any other missions in which rapid reaction is not a factor.

d. *Distribution.* The desired burst pattern in the impact area. Common examples include:

(1) "PARALLEL SHEAF." All weapons will fire the same data.

(2) "PRIMARY SECTOR", "LEFT SECTOR", or "RIGHT SECTOR". Terrain Gun Position Corrections (TGPC) will be applied for the designated sector (see chapter 10). To cancel TGPC for a mission, "CANCEL TERRAIN CORRECTIONS" is announced.

(3) "SPECIAL CORRECTIONS." Different sets of firing data will be announced for various weapons. This command may be used with a description of the desired sheaf (e.g., "SPECIAL CORRECTIONS, CONVERGED SHEAF") or with TGPC announcements. In the latter use, TGPC announcements are made first; e.g., "CANCEL TERRAIN CORRECTIONS; SPECIAL CORRECTIONS".

e. *Projectile.* The type of projectile to be used in the adjustment phase. It will also be used in FFE unless a change is announced in the NUMBER OF ROUNDS element.

f. *Ammunition lot and charge.* The projectile lot, propellant lot, and charge to be used throughout the fire mission. Rapidly select the charge to be fired based on your examination of the target plot. The following exceptions apply:

(1) If high angle fire is to be used, substitute the words "HIGH ANGLE". The computer will then select the charge to be fired; it may change during the mission.

(2) FADAC will select the best charge based on range. If you desire FADAC to select the charge, tell the operator. In most tactical situations, however, you will designate the charge (to achieve the lowest practicable trajectory and to insure FADAC compatibility with first-round graphical solutions).

(3) If different projectile or propellant lots are to be used in adjustment and fire for effect, the adjusting lots will be designated here. The FFE lots will be announced as part of the NUMBER OF ROUNDS element.

g. Fuze. The type of fuze to be used in the adjustment phase. It will also be used in FFE unless a change is announced by the FDO in the NUMBER OF ROUNDS element.

h. Number of rounds. The number of rounds to be fired by each weapon designated in the UNIT TO FIRE. If different projectiles, ammunition lots, or fuzes are to be used in adjustment and FFE, the FFE ammunition will be announced here.

Note. The main consideration for you in your fire order is the determination of shell/fuze combination and number of rounds to be fired.

i. Range spread, lateral spread, zone or sweep. Techniques used to attack large or irregularly-shaped targets.

j. Time of opening fire. Designated time to begin firing.

Note. TARGET NUMBER has been eliminated as a fire order element. When a target number is assigned, it will either be done before the fire order is issued (as with planned targets or registration points) or after the mission is fired (as with replotted targets of opportunity).

Use common sense in issuing fire orders. Fire order formats are designed to disseminate information clearly and rapidly with a minimum of discussion, but if a situation requires it, necessary clarification should be provided. In other words, the FDO must "use" the system, not "be used" by it. It is impossible to provide a textbook solution for every conceivable situation, but a combination of technical knowledge and common sense should be sufficient to avoid confusion. It is better, if any possibility of confusion exists, to be redundant rather than too brief.

Note. The vast majority of the time, adjust fire standards as in para 9-4a will be established.

BEFORE REGISTERING, ANNOUNCE THE TYPE OF REGISTRATION TO BE CONDUCTED; E.G., "PRECISION REGISTRATION," "HIGH BURST REGISTRATION" OR "MEAN-POINT-OF-IMPACT REGISTRATION." YOU MAY THEN OMIT FROM THE FIRE ORDER: DISTRIBUTION; NUMBER OF ROUNDS; RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP.

9-4. Examples of Fire Orders

Sample fire order standards and resultant fire order samples are provided in paragraphs 9-4a through 9-4c.

a. Example 1.

ELEMENT	SAMPLE TACTICAL SITUATION: Maneuver units preparing to advance. FDO anticipates observers will be required to adjust fire on most targets; establishes the following fire order standards:	SAMPLE CALL FOR FIRE: "H44, ADJUST FIRE, OVER-GRID 196432, OVER -- COMPANY ASSEMBLY AREA, VT IN EFFECT; OVER." FDO ACTIONS: Agrees with observer's call for fire; desires to fire two rounds in effect. Issues following fire order:
UNIT TO FIRE	BATTERY	
ADJ ELEMENT/MOF OF ADJ ELEMENT	# 3 ①	
BASIS FOR CORRECTIONS	FASTEST METHOD	
DISTRIBUTION	PARALLEL SHEAF	
PROJECTILE	HE	
AMMO LOT & CHARGE	RT/4	
FUZE	Q	
NUMBER OF ROUNDS	①	② , VT IN EFFECT
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RG & DF	
TIME OF OPENING FIRE	WHEN READY	

MESSAGE TO OBSERVER: "BRAVO, TWO ROUNDS, OVER. "

b. Example 2.

ELEMENT	SAMPLE TACTICAL SITUATION: Maneuver units in defensive posture. Targets in fire plan are plotted and corrections have been determined. Variety of targets expected. FDO anticipates he can FFE most of the time; establishes the following fire order standards:	SAMPLE CALL FOR FIRE: "H44, ADJUST FIRE, OVER—GRID 187437, OVER — INFANTRY SQUAD DIGGING IN, OVER." FDO ACTIONS: Agrees with observer's request for adjust fire; desires to use different ammo lot; disagrees with request for fuze quick in effect; desires to fire four rounds (VT) in effect. Issues following fire order:
UNIT TO FIRE	BATTERY	
ADJ ELEMENT/MOF OF ADJ ELEMENT	FIRE FOR EFFECT	ADJUST FIRE, # 3 ①
BASIS FOR CORRECTIONS	FASTEST METHOD	
DISTRIBUTION	PRIMARY SECTOR	
PROJECTILE	HE	
AMMO LOT & CHARGE	SW/5	LOT SY
FUZE	VT	FUZE Q
NUMBER OF ROUNDS	①	④, VT IN EFFECT
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RG & DF	
TIME OF OPENING FIRE	WHEN READY	

MESSAGE TO OBERVER: "BRAVO, VT IN EFFECT, FOUR ROUNDS, OVER"

c. Example 3.

ELEMENT	SAMPLE TACTICAL SITUATION: Supported unit moving to contact with enemy. FDO anticipates initial missions will require suppression of fleeting targets; establishes the following standards:	SAMPLE CALL FOR FIRE: "H44, IMMEDIATE SUPPRESSION, GRID 188445, OVER". FDO ACTIONS: Agrees with observer's call for fire. Issues following fire order:
UNIT TO FIRE	—— PLATOON	CENTER
ADJ ELEMENT/MOF OF ADJ ELEMENT	FIRE FOR EFFECT	
BASIS FOR CORRECTIONS	FASTEST METHOD	
DISTRIBUTION	PARALLEL SHEAF	
PROJECTILE	HE	
AMMO LOT & CHARGE	SW/5	
FUZE	VT	
NUMBER OF ROUNDS	② , 2d RD WP/O	
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RG & DF	
TIME OF OPENING FIRE	WHEN READY	

MESSAGE TO OBSERVER: "PLATOON, HE VT AND WP QUICK, TWO ROUNDS, OVER"

9-5. Fire Commands

a. To increase responsiveness, fire commands have been modified and streamlined. Standard elements (adjusting piece, projectile, ammunition lot and fuze) may be determined by the FDC and announced to the

guns. These designated elements need be announced only when something other than standard is to be fired. The FDC will insure that all howitzer sections are informed when the standard changes. The elements and sequence of the new fire commands are:

SEQUENCE OF ELEMENTS	WHEN ANNOUNCED	
	Initial Fire Command	Subsequent Fire Command
1. Warning Order	Always	Never
2. Pieces to Follow/Pieces to Fire*/ Method of Fire*	Always	When Applicable
**3. Special Instructions: Do Not Load At My Command/By Piece At My Command High Angle Use Gunner's Quadrant Azimuth Primary Sector/Left Sector/Right Sector Cancel Terrain Corrections Special Corrections	When Applicable	When Applicable
*4. Projectile	When Not Standard	When Changed
*5. Ammunition Lot	When Not Standard	When Changed
6. Charge	Always	When Changed
*7. Fuze/Fuze Setting	When Not Standard	When Changed
8. Direction (announced as DEFLECTION _____)	Always	When Changed
9. Quadrant Elevation	Always	Always
10. Method of Fire For Effect	When Applicable	When Changed

*Element may be standardized and not announced in initial fire commands.

**When TGPC (see chapter 10) are being used, unit SOP will determine what correc-

tions will be applied. Normally, the corrections for the primary sector will be carried on the weapons unless the command "Left Sector", "Right Sector", or "Cancel Terrain Corrections" is announced by the FDC.

b. Examples of fire command standards.

ELEMENT	ADJUST FIRE MISSIONS ANTICIPATED	FIRE FOR EFFECT MISSIONS ANTICIPATED
WARNING ORDER		
PIECES TO FOLLOW/PIECES TO FIRE/METHOD OF FIRE	# 3 ①	BATTERY ①
SPECIAL INSTRUCTIONS		
PROJECTILE	HE	HE
AMMO LOT	RT	RT
CHARGE		
FUZE/FUZE SETTING	Q	VT/9.0
DIRECTION		
QUADRANT		
METHOD OF FFE		

c. The command *QUADRANT (so much)* is permission for the chief of section to load and fire the round unless otherwise restricted by special instructions. Alternative procedures may be adopted by the firing battery as local SOP. These procedures often impact on the FDC and, hence, require FDC personnel to be knowledgeable in handling these situations. Three of the more prominent of these alternatives are:

■ Loading on the command DEFLECTION (so much).

■ Adjusting piece(s) loading subsequent rounds immediately after firing.

■ Nonadjusting pieces loading the shell to be fired in effect upon receipt of initial fire commands.

THE DECISION TO USE THESE TECHNIQUES IS MADE BY THE COMMANDER, AND IS INFLUENCED BY THE STATE OF TRAINING OF THE FDC AND GUN CREWS.

(1) Loading on deflection. This procedure is especially effective for those units where loading will not interfere with receipt of the remaining fire commands. For self-propelled units, adoption of this procedure may require that the FDC pause *momentar-*

ily between the commands for deflection and quadrant. In any case, the FDC must insure that there are no *long* delays between the commands deflection and quadrant so that rounds are not loaded and left in the tube for an extended period of time.

(2) Adjusting piece(s) load subsequent rounds immediately after firing. Using this SOP, it is possible, when entering FFE, that the adjusting piece(s) may not have the correct shell/fuze combination loaded. The chief of section will at the end of the mission, (as always), report if his piece fired other than the ammunition announced in the fire command. For example:

NUMBER 4 FIRED 1 QUICK AND 2 VT IN EFFECT*

*Rather than 3 VT.

The FDC will correct the ammunition count on the Record of Fire to reflect the report.

(3) Nonadjusting pieces load the shell to be fired in effect upon receipt of the initial fire commands. This SOP is particularly valuable when the FFE fuze is fuze quick and is obviously not applicable to mechanical time fuzes. When the FFE fuze is fuze VT, the FDC calculates and sends to the nonadjust-

ing pieces the VT fuze setting to the initial target location. If terrain, weather, and enemy capabilities allow it, an alternative procedure is to use the VT minimum safe time.

9-6. Sample Fire Mission Using Standard Elements

Sample missions using standard fire order and fire command elements are provided in tables 9-1 and 9-2.

Table 9-1. Sample fire mission using standard fire order and fire command elements.

SAMPLE TACTICAL SITUATION: Supported units preparing to advance. FDO anticipates observers will be required to adjust fire on most targets.			CALL FOR FIRE: "H44, AF, OVER-GRID 202610, OVER-MORTAR PLATOON FIRING, OVER".		
			FDO ACTIONS: Agrees with observer's call for fire; determines that target is located in the primary TGPC Sector; desires to fire four rounds, issues fire order below.		
FIRE ORDER			FIRE COMMAND		
ELEMENT	STANDARD	ANNOUNCED BY FDO	ELEMENT	STANDARD	INITIAL FIRE COMMAND ANNOUNCED BY FDC
UNIT TO FIRE	BATTERY		WARNING ORDER		FIRE MISSION
ADJ ELEMENT/MOF OF ADJ ELEMENT	# 3 ①		PIECES TO FOLLOW/PIECES TO FIRE/METHOD OF FIRE	# 3 ①	BATTERY ADJUST
BASIS FOR CORRECTIONS	FASTEST METHOD		SPECIAL INSTRUCTIONS		
DISTRIBUTION	PRIMARY SECTOR		PROJECTILE	HE	
PROJECTILE	HE		AMMO LOT	RT	
AMMO LOT & CHG	RT/4		CHARGE		CHG 4
FUZE	O		FUZE/FUZE SETTING	O	
NUMBER OF ROUNDS	①	④	DIRECTION		DF 2712
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RG & DF		QUADRANT		QUADRANT 289
TIME OF OPENING FIRE	WHEN READY		METHOD OF FFE		④ IN EFFECT

MESSAGE TO OBSR. "BRAVO FOUR ROUNDS, OVER."

*Primary Sector TGPC Applied Per Unit SOP

Table 9-2. Sample fire mission using standard fire order and fire command elements.

SAMPLE TACTICAL SITUATION: Supported units on defensive. FDO anticipates he will be able to FFE on most targets without adjustment.			CALL FOR FIRE: "H44, ADJUST FIRE, OVER—GRID 216837, OVER—INFANTRY PLATOON ADVANCING IN OPEN, VT IN EFFECT, OVER."		
			FDO ACTIONS: Agrees with observer's call for fire, notes that target can be engaged by either Charge 4 or Charge 5; selects higher charge to achieve faster time of flight and lower trajectory; desires to fire four rounds in effect.		
FIRE ORDER			FIRE COMMAND		
ELEMENT	STANDARD	ANNOUNCED BY FDO	ELEMENT	STANDARD	INITIAL FIRE COMMAND ANNOUNCED BY FDC
UNIT TO FIRE	BATTERY		WARNING ORDER		FIRE MISSION
ADJ ELEMENT/MOF OF ADJ ELEMENT	FIRE FOR EFFECT	ADJUST FIRE # 3 ①	PIECES TO FOLLOW/PIECES TO FIRE/METHOD OF FIRE	BATTERY ①	BATTERY ADJUST # 3 ①
BASIS FOR CORRECTIONS	FASTEST METHOD		SPECIAL INSTRUCTIONS	*	
DISTRIBUTION	PRIMARY SECTOR		PROJECTILE	ICM	SHELL HE
PROJECTILE	ICM	SHELL HE	AMMO LOT	SY	LOT RT
AMMO LOT & CHG	SY/4	LOT RT, CHG 5	CHARGE		CHG 5
FUZE	TIME	FUZE Q	FUZE/FUZE SETTING	TIME	FUZE Q
NUMBER OF ROUNDS	①	④ VT IN EFFECT	DIRECTION		DF 3354
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RG & DF		OUADRANT		OUADRANT 265
TIME OF OPENING FIRE	WHEN READY		METHOD OF FFE		④ VT IN EFFECT
			*Primary Sector TGPC Applied Per Unit SOP		

MESSAGE TO OBSR: "BRAVO, FOUR ROUNDS, OVER".

REGISTRATION COMPUTATIONS																													
ACHIEVED RANGE							DEFLECTION CORRECTION																						
① Chart Rg		(10M)					⑥ Corr Df (Reg)		(10M)																				
② BP Displ (F-/B+)		(10M)					⑤ BP Displ Corr (L+/R-)		(10M)																				
③ Achieved Rg (① + ②)		(10M)					⑦ Adj Df (⑥ + ⑤)		(10M)																				
BP DISPLACEMENT CORRECTION							⑧ Chart Df																						
④ Lateral Displ (L/R)		(5M)					⑨ Total Df Corr (⑦ - ⑧) (+L/-R)		(10M)																				
③ Achieved Rg		(10M)					⑩ Drift Corr (~ Adj El) (L)		(10M)																				
⑤ BP Displ Corr (④ - ③) L/R		(10M)					⑪ GFT Df Corr (⑨ - ⑩)		(10M)																				
GFT _____: Chg _____ Lot _____ Rg _____ El _____ Ti _____												DEFLECTION CORRECTION																	
GFT _____: Chg _____ Lot _____ Rg _____ El _____ Ti _____												Total	GFT																
FADAC RESIDUALS Df ± _____ Fz ± _____ Rg K ± _____																													
TRANSFER OF GFT SETTING																													
①		②		③		④		⑤		⑥		⑦																	
Btry		Bn BP Camp VE		MV Corr Factor D+ _____ I- _____		MV Rg Corr ① × ② = ()		Achieved Rg		Corr Rg ③ × ④ = ()		El ~ ⑤ (Use El Gageline) Ti ~ ⑤ (Use Ti Gageline)																	
M/S		M		10M		10M		10M		m		FS																	
SPECIAL CORRECTIONS FOR TERRAIN GUN POSITION																													
TRANSFER LIMITS																													
L/P/R Sector Chg (s) _____																													
Az (L) _____ (R) _____																													
Df (L) _____ (R) _____																													
Rg (Min) _____ (Max) _____																													
		①		②		③		④		⑤		⑥		⑦		⑧		⑨		⑩		⑪		⑫					
Gun		Corr To Burst Line		Dir Of Corr T- → BC ← A- ← BC →		Lateral Displ From BC (L/R)		Desired Lateral Displ From BC (L/R)		Lateral Corr Required (L/R) ② - ① =		100/R GFT T Min Rg A Mox Rg		Pos Df Corr (L/R) ③ × ④ / 100 =		Btry Camp VE		MV Corr Factor (Table F) D+ _____ I- _____		MV Rg Corr ⑥ × ⑦ =		Pas Rg Corr (F = -) (B = +)		Total Rg Corr ⑧ + ⑨ =		Rg Change Per Mil Factor (Table F)		Pos El Corr ⑩ / ⑪ =	
#		#		T/A		M		M		M		m		m		M/S		M		M		M		M		m			
1																													
2																													
3																													
4																													
5																													
6																													

Figure 9-2. Record of Fire (back side).

(a) Call for fire block. A reorganized and enlarged CALL FOR FIRE block serves the same function as the corresponding block of the Computer's Record. The sequence of the elements within the block has been revised to correspond to the newly revised call for fire. Blanks have been provided for each element in a manner designed to reduce the amount of information that must be written by the RTO/computer. The "AF/FFE/IS/S" found after the observer identification stand for "ADJUST FIRE", "FIRE FOR EFFECT", "IMMEDIATE SUPPRESSION", and "SUPPRESS" respectively.

(b) Computation space. The blank space in the upper right corner of the form is used for any computations needed for initial fire commands for which space has not been provided elsewhere; e.g., addition of GFT deflection correction and drift correction. It can also be used as space for recording

lengthy calls for fire.

(c) High angle site section. The information required to compute high angle site is recorded in the Δ Si ÷ 10 and 10 Δ Si blocks.

(d) Δ FS and 100/R block. In this space the Δ FS, 100/R, and required derivatives of 100/R are recorded.

(e) Fire order block. The computer records only the announced elements in the FIRE ORDER block. Anything not specifically announced by the FDO will be in accordance with the current fire order standards.

(f) Initial fire commands section. Only nonstandard elements are recorded in this section. Shaded blocks indicate data that must always be announced to the firing battery (a fuze setting is announced only when time or proximity fuzes are being fired). The

data required for computing initial firing data are recorded in the area to the right of the FIRE ORDER block and above the INITIAL FIRE COMMANDS section. This area is designed to facilitate computation of the initial deflection and QE to be fired by providing a column arrangement for addition of their subelements.

(g) Message to observer (MTO) block. The message to observer is recorded in the MTO block.

(h) Angle T, P_{ER}, and TF blocks. These blocks are used as required by the computer. The information is sent to the observer as necessary.

(i) Subsequent fire commands section. In appearance and use, this section is similar to the corresponding section of the Computer's Record. Differences are as follows:

- The observer subsequent correction columns can also be used to record information concerning planned targets. The encrypted locations of planned targets are converted to grid coordinates and recorded on the form. Platoons to fire may be denoted by R, L, or C and pieces to fire by the appropriate piece number.

- Observer direction for a grid mission is announced after submission of the call for fire but is recorded on the first subsequent correction line as if it were a change in direction.

- Shading highlights actual firing data to set it apart from intermediate data. Data recorded in shaded columns must be announced to the firing battery. The exceptions are fuze setting and deflection if they have not changed from those previously announced.

- The sequence shown corresponds to the revised fire commands discussed above. The CHART RANGE block has been placed to make it inconvenient to write this information down until after it is set off on the GFT.

- THE SITE RECORDED ON EACH LINE IS THE "TOTAL" SITE. Elevation and site must be combined for each

round to determine the QE.

- Two columns on the extreme right of the form have been provided for recording expenditures of ammunition by type. A **CHECKMARK IS MADE WHEN MISSION EXPENDITURES HAVE BEEN POSTED TO OTHER RECORDS/CHARTS.**

(j) Computation space (bottom of form). This space is to be used for recording observer surveillance and performing additional computations, such as for replot.

(k) Administrative and replot data section. The bottom line of the Record of Fire is a combination of the top line and the DATA FOR REPLOT block of the Computer's Record. Appropriate data are entered after the mission has been completed and are arranged to facilitate reports to higher headquarters. The DTG will pinpoint the time at which effect was placed on the target. A target number is not assigned unless requested by the FO or designated by the FDO; then it is provided to the FO at the end of the read-back of his surveillance.

(4) The back of the form, like the front, is divided into major sections separated by heavy black lines.

(a) Registration computations section. Doctrine prescribes that the base piece location will be battery center. This section is provided for use in the computation of registration corrections whenever it is necessary to register with other than the base piece. Sequential steps are listed for determining achieved range and a base piece displacement correction. The steps for computation of the total deflection correction and the GFT deflection correction will always be used.

(b) GFT settings block. Two GFT settings can be recorded in this block.

(c) Deflection correction block. The total and GFT deflection corrections are recorded in this block.

(d) FADAC residuals section. This area is used to record the FADAC residual data obtained through registration.

(e) Computation spaces. The blank spaces on the back of the form are used for any required computations or information (e.g., recording additional GFT settings).

(f) Transfer of GFT setting section. This section is used for transferring GFT settings from a registering battery (or roving gun) to nonregistering batteries by computing corrections to compensate for differences between piece MV's.

(g) Special corrections for terrain gun position section. This section is used for computing and determining position/special corrections to compensate for irregularly shaped battery positions.

c. An example showing the use of the Record of Fire in conjunction with fire order and fire command standard elements (fig 9-3) is provided in figure 9-4.

FIRE ORDER STANDARDS

ELEMENT	CURRENT STANDARD
UNIT TO FIRE	BATTERY
ADJUSTING ELEMENT/ METHOD OF FIRE OF ADJUSTING ELEMENT	#3 ①
BASIS FOR CORRECTIONS	FASTEST METHOD
DISTRIBUTION	PARALLEL SHEAF
PROJECTILE	HE
AMMUNITION LOT AND CHARGE	YZ/4
FUZE	0
NUMBER OF ROUNDS	①
RANGE SPREAD, LATERAL SPREAD, ZONE OR SWEEP	CENTER RANGE AND DEFLECTION
TIME OF OPENING FIRE	WHEN READY

FIRE COMMAND STANDARDS

ELEMENT	STANDARD ELEMENTS BY CURRENT SOP
WARNING ORDER	
PIECES TO FOLLOW/ PIECES TO FIRE/ METHOD OF FIRE	#3 ①
SPECIAL INSTRUCTIONS	
PROJECTILE	HE
AMMUNITION LOT	YZ
CHARGE	
FUZE/FUZE SETTING	0
DIRECTION	
QUADRANT ELEVATION	
METHOD OF FIRE	

Figure 9-3. Fire order and fire command standards - example.

RECORD OF FIRE															
Observer <u>H8T32</u>		CALL FOR FIRE <u>(AF) FFE/IS/S</u>		Tgt _____				△ FS							
Grid: <u>619378</u>										100/R <u>19</u>					
Polar Dir _____		Dis _____		U/D _____		VA ± _____				/R					
Shift <u>PLATOON DIGGING IN</u>		Dir _____		L/R _____		+/- _____		U/D _____		20/R <u>4</u>					
FIRE ORDER <u>(2)</u>								★ Si-10		10m Si		HOB Corr			
INITIAL FIRE COMMANDS		FM MF <u>BTRY ADJUST</u>		Rg <u>5300</u>		Df Corr <u>L11</u>		Cht Df <u>2943</u>		Si <u>+7</u>		EI <u>318</u>			
Sp Instr		Sh		Lot		Chg <u>4</u>		Fz		Ti		Df <u>2954</u>		QE <u>325</u>	
MTO <u>BRAVO (2)</u>		★ T		PE _R		TF		(2) in Eff		Ammo Exp (1)					
SUBSEQUENT FIRE COMMANDS															
Tgt	Location	Priority	Firing Unit	MF, Sh	FS	Ti	Chart Df	Df Corr (L11)	Df Fired	Chart Rg	HOB Corr	Si (+7)	EI	QE	AMMO
Dir, MF Sh, Fz	Dev	Rg	HOB Corr	MF, Sh Chg, Fz	FS Corr	Ti	Chart Df	Df Corr (L11)	Df Fired	Chart Rg	HOB Corr	Si (+7)	EI	QE	Exp Type
<u>DIR 420</u>	<u>L90</u>	<u>-200</u>					<u>2968</u>	<u>L11</u>	<u>2979</u>	<u>5120</u>		<u>+7</u>	<u>304</u>	<u>311</u>	(2)
	<u>R40</u>	<u>+100</u>					<u>2956</u>	<u>L11</u>	<u>2967</u>	<u>5200</u>		<u>+7</u>	<u>310</u>	<u>317</u>	(3)
									<u>(2967)</u>			<u>+4</u>	<u>+11</u>	<u>310</u>	<u>317</u>
														<u>321</u>	(12) YT
PLT DISP EST 15 CAS															
Btry <u>B</u>		DTG <u>221400 APR 76</u>		Tgt		Replot Grid		Replot Alt							

FORM 1 MAY 76 4504

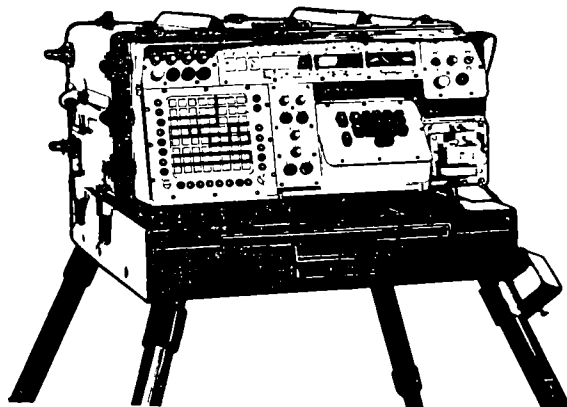
Replaces DA Form 3622, 1 Jan 74 and DA Form 4007, 1 Jan 73.

For use of this form, see FM 6-40 and FM 6-40-5. The proponent agency is US Army Training and Doctrine Command.

Figure 9-4. Record of Fire--adjust fire mission.

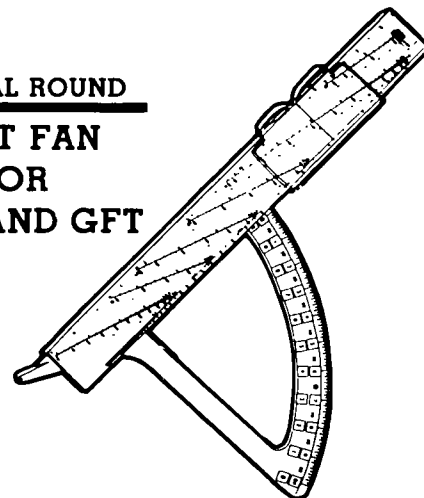
9-8. Target of Opportunity

a. *The basis for correction.* The basis for correction for the first round on a target of opportunity is normally the manual procedure in which the GFT fan or the GFT is used with a FADAC-derived GFT setting. In most instances, both manual procedures are faster than the FADAC, which requires two-thirds the time of flight to compute initial data.



ALL SUBSEQUENT ROUNDS
FADAC

INITIAL ROUND
GFT FAN
OR
RDP AND GFT



The GFT fan is currently the most rapid means of determining firing data because all basic data can be read directly from one instrument. Although GFT (fan) data are normally fired, the FADAC must also compute initial data so that all subsequent rounds can be fired using FADAC. The use of the FADAC-derived GFT setting on the graphical equipment will produce data comparable to those determined by FADAC.

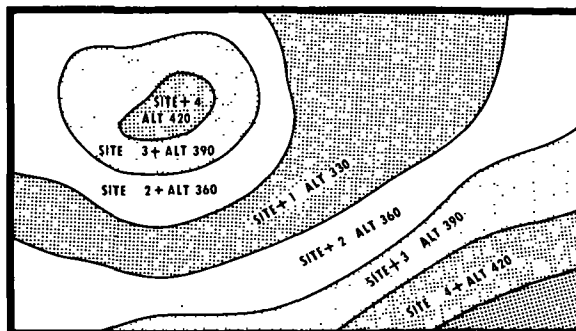
b. Average site. Time will be saved by computing an average site for each 30-meter or 100-foot vertical interval. The error in site will not exceed the error normally introduced by the total system and, therefore, is an acceptable trade-off of accuracy for speed. This technique may not be practical in certain situations, for example, in mountainous terrain or in fast-moving operations. With the GST, compute site for each 30-meter interval using the charge that will be fired and the range and altitude to the center of the 30-meter interval. Each 30-meter vertical interval on the VCO map should be color coded and marked with the average site and the altitude used for that site. For a target located by grid coordinates, the VCO will need only to estimate the target location and read the site. The corresponding altitude will be used in FADAC.

c. 20/R. If speed is critical, 20/R will be ignored when determining initial firing data for VT rounds.

d. VT fuze setting. The FDC should precompute the minimum safe VT fuze setting for the standard charge in each position and send it to the guns.

e. Immediate smoke. Immediate smoke (WP or HC) may be fired with the same firing data as used for HE, provided a correction of minus two seconds is applied to the HE fuze setting to obtain the fuze setting for the HC smoke.

f. Highest practical charge. The highest practical charge will be fired to decrease the time of flight and thereby put steel on the target faster. For smoke and illumination missions, a tradeoff must be made between responsiveness/survivability and possible damage to the smoke canisters and the flare parachute.



VCO MAP COLOR-CODED AND MARKED WITH AVERAGE SITE AND CORRESPONDING ALTITUDE

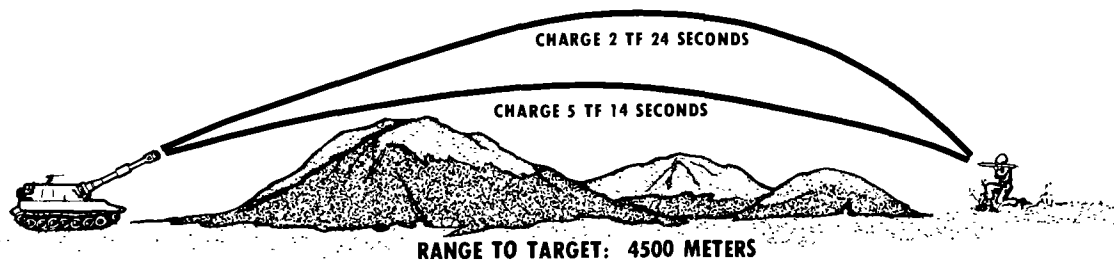
Also, remember a lower charge may give better effects, save wear and tear on the howitzer, and reduce the possibility of detection by flash and sound ranging. The FDO must carefully analyze the terrain when selecting the charge to fire. Intervening crests may require a lower charge.

9-9. Determination of Platoon Centers/Piece Locations Using FADAC

a. General. In order to determine platoon/piece firing data using FADAC, the grid locations of the platoons/pieces must be known. By a simple FADAC technique, the displacements from battery center can be converted to grid locations.

b. Situation. Given the following information and a FADAC, determine piece and platoon grid locations.

- (1) All values set to standard (SET UP).
- (2) Battery Grid - 84310 76520 Alt 512.
- (3) Azimuth of Lay - 0800m.
- (4) Referred Deflection - 3200.
- (5) Grid Declination - 0.
- (6) Latitude - 34°N.



(7) Piece	Piece displacement from BC	
#1	130R	40B
#2	55R	50B
#3(BP)	0	0
#4	35L	40B
#5	40L	95F
#6	190L	20F

c. *Solution.*

Step	Action
1	Input the known data (b(1) through b(6) above).
2	Enter the battery center grid as a target using matrix 1 locations A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT).
3	Store the target on the target list (E-3 (TGT STORE)). Use any convenient file number; e.g., 100.
4	Enter the azimuth of lay in matrix location A-5 (OT DIR).
5	Enter the piece displacement using matrix locations A-6 (RIGHT/LEFT) and A-7 (ADD/DROP).
6	Depress the COMPUTE button; wait 5 seconds, depress the RESET button.
7	Using matrix location A-4 (TGT RECALL), depress the SM key, type 0 and ENTER on the keyboard. The grid of the piece will be displayed.
8	Depress the SM key again and type file number (100) of the battery center grid stored location.
9	Repeat steps 5 through 8 for the next piece.

The following grid locations are determined:

Piece	Grid
#1	8437476400
#2	8431476446

#3 (BP)	8431076520
#4	8425776516
#5	8434976615
#6	8419076668

Platoon	Grid
Right	8434476423 (average of #1 and #2)
Center	8428376518 (average of #3 and #4)
Left	8427076641 (average of #5 and #6)

If you desire only platoon grids, the same procedures described in (1) through (8) apply except that the average displacement of the platoon from battery center is input; e.g., right platoon is $\frac{130R + 55R}{2} = \frac{185R}{2} = 62.5R \approx 62R$

and $\frac{40B + 50B}{2} = \frac{90B}{2} = 45B$.

9-10. Irregularly Shaped Targets (Special Corrections)

The FDC is responsible for planning fires to effectively engage irregularly shaped targets. Individual piece or platoon firing data will be computed so that the burst from each piece falls at the intended point on the target.

a. FADAC solution.

(1) Platoon concept. Place the:

(a) Right platoon center in the D Btry position along with the average MV of pieces 1 and 2.

(b) Center platoon center in the appropriate battery position along with the average MV of pieces 3 and 4.

(c) Left platoon center in the E Btry position along with the average MV of pieces 5 and 6.

(2) Individual gun concept. Place:

(a) Piece #1 location and MV in the A Btry position.

(b) Piece #2 location and MV in the B Btry position.

(c) The battery (or center platoon) center and base piece MV (AVG MV if center platoon is used) in the C Btry position.

(d) Piece #5 location and MV in the D Btry position.

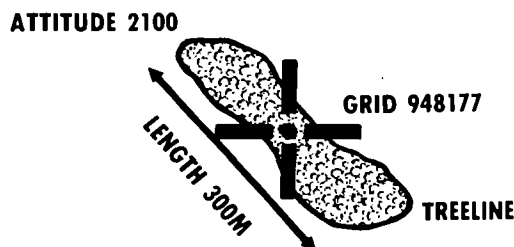
(e) Piece #6 location and MV in the E Btry position.

(3) The procedure for the platoon concept and that for the individual gun concept are basically the same. Upon receipt of the call for fire on an irregularly shaped target, determine which weapons will engage the target and at what intervals (positions on the target).

(4) The FO may describe an irregularly shaped target as a number of subtargets (grids) or as a point, an attitude and a length. From an FDC standpoint, the description by subtargets is the most desirable since then each target may be assigned to a platoon (or piece) and firing data computed rapidly. If the target is described in another manner, mass fire procedures are used to transfer target data from platoon to platoon or gun to gun.

(5) Example (platoon concept).

(a) The observer requests that fire be planned on the irregularly shaped target shown.



H18 THIS IS H24, OVER.

GRID 948177, OVER.

SUSPECTED ATGM POSITIONS IN TREELINE, ATTITUDE 2100, LENGTH 300, RECORD AS TARGET 271, OVER.

(b) You analyze the target and decide to fire platoon subtargets 100 meters apart.

(c) The FADAC operator enters the announced grid and the altitude (from map) into FADAC. He then enters the attitude of 2100 as the OT direction into FADAC, adds 100, computes, and records firing data for the right platoon. Using mass fire techniques, he then drops in 100-meter increments to determine the firing data for the center and left platoons.

b. Manual solution. Accurate special corrections to attack an irregularly shaped target can be determined manually using the M17 plotting board. This can be a time consuming procedure, however. So when time is short, consider using:

(1) Deflection difference (FM 6-40).

(2) Zone fire (FM 6-40). This technique is appropriate for targets whose depth is generally parallel to the GT line.

(3) Sweeping fire. Sweeping fire is to deflection what zone fire is to quadrant. It is appropriate for wide targets generally perpendicular to the GT line. (For details, see zone and sweep.)

(4) Zone and sweep. This technique combines zone fire and sweeping fire, and is valuable in attacking large targets. Four pieces of information are needed to engage a target using the zone and sweep:

(a) Target size.

(b) Range to target and charge to be fired.

(c) Desired density of bursts (aim points) within the target, the number of deflections and quadrants to be fired.

(d) Range change/mil factor and 100/R at range to the target. With this information, the FDC will determine the number of mils to move deflection and quadrant to cover

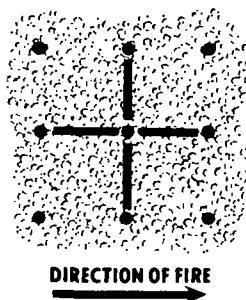
the target. The deflection and quadrant announced in the fire commands must be fired first by all pieces indicated in the method of fire. Each chief of section then determines the method by which he will fire the remaining deflections and quadrants.

VULNERABILITY CONSIDERATIONS MAY CALL FOR ENGAGING THE TARGET WITH MULTIPLE FIRING UNITS RATHER THAN WITH A SINGLE UNIT EMPLOYING ZONE, SWEEPING, OR ZONE AND SWEEP FIRES.

(5) Example of zone and sweep.

(a) You plan to employ a platoon to attack a target with aim points every 100 meters; three deflections and three quadrants will be fired.

TARGET DIMENSIONS 300 x 300 METERS



WEAPON DATA

M109A1

RANGE TO TARGET 5000 M

CHARGE 4 GB

(b) The range change/mil factor for charge 4GB range 5000 is 13 meters (FT 155-AM-1). Since aim points are desired every 100 meters, the size of the zone to be fired is 8 mils ($100 \div 13 \approx 8$).

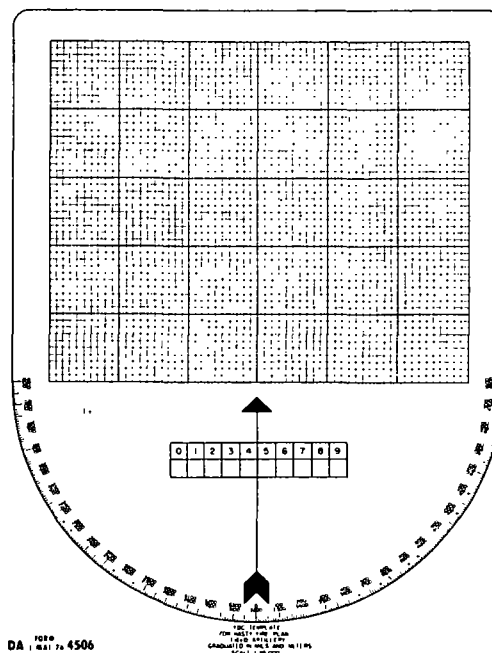
(c) Using the 100/R value of 20 from the GFT, you determine the size of the sweep to be 20 mils.

THE COMMANDS TO THE GUNS INCLUDE: RIGHT (1), SWEEP 20 MILS, 3 DEFLECTIONS, ZONE 8 MILS, 3 QUADRANTS, DF __, QE __.

9-11. Fire Planning (Hasty)

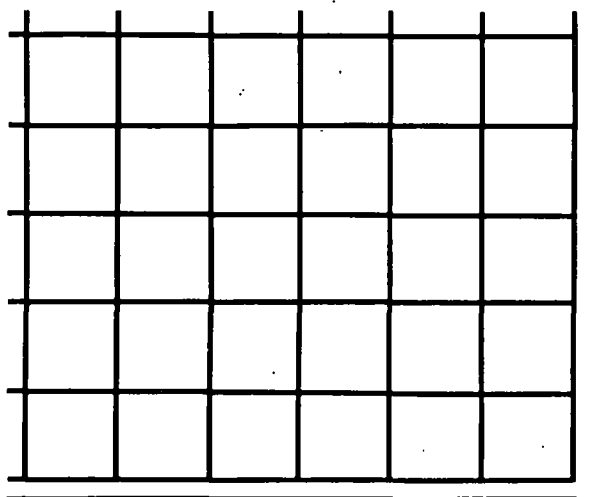
a. *Placing the hasty fire plan on the firing chart.* The gridded template, constructed on

a scale of 1/50,000, cannot be used to plot targets and checkpoints on the 1/25,000 firing chart. A 1/25,000 scale duplicate of the gridded template, DA Form 4506, will allow plotting the fire plan rapidly and accurately on

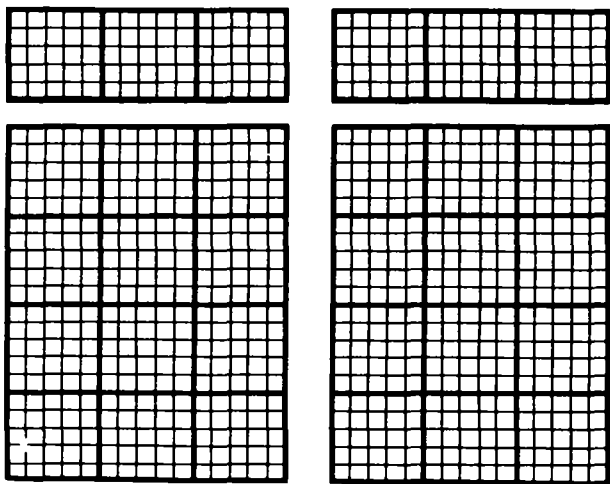


the firing chart. Although available through publications channels, in an emergency combat situation, you can construct a substitute by performing the following steps:

(1) Cut a 5-by-6-grid-square section of a transparent plastic firing chart, leaving the edges for recording the template code. From



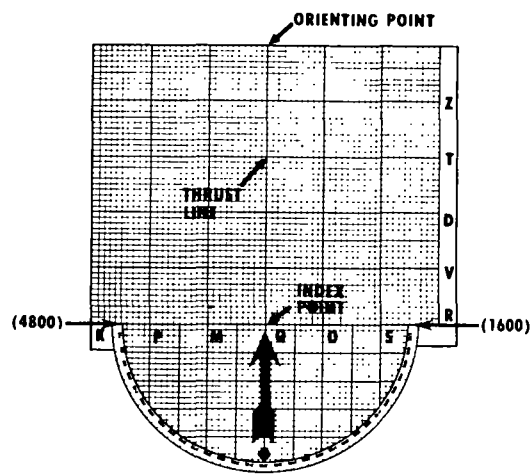
the target grid (DA Form 4176), piece together as necessary with transparent tape, a 5-by-6-grid-square section.



(2) Aline the target grid square on the back of the section of chart.

(3) Mark the orienting point and the index point.

(4) Cut a target grid in half at the 1600-4800 line. Draw an arrowhead at the top of the center line on the bottom half of the target grid. Numbering from the left, print 4800 above 1600, 4900 above 1700, and so on until all preprinted numbers are also labeled with their back azimuth. Tape the target grid to the half section as shown.



(5) Label template grid lines according to the observer's coded message and plot the index and orienting points on the firing chart.

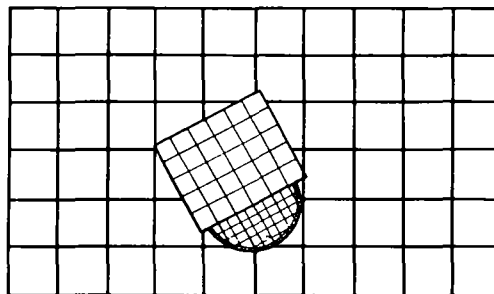
(6) The template may be oriented in either of two ways:

(a) Aline the index and orienting points of the template with the same points on the firing chart, OR

(b) Plot the index point and, with a direction furnished by the observer, orient the template and therefore the thrust line.

(7) The template may now be used to plot coded target and checkpoint locations directly on the firing chart.

WHENEVER A MANEUVER CHECKPOINT IS PLOTTED ON THE FIRING CHART, IT WILL BE IDENTIFIED BY A BLUE TICKMARK AND THE CHECKPOINT NUMBER, SYMBOL, AND ALTITUDE.



b. Placing the hasty fire plan in FADAC.
It is not necessary to determine the grid of each point of the fire plan prior to entering it in FADAC. The FADAC revision 5 matrix one allows an easier and faster procedure.

(1) Decode the grid of the index point from the observer's message. Enter that grid in A-1 (TGT EAST) and A-2 (TGT NORTH).

(2) Determine the altitude of the index point from the situation map. Enter the altitude in A-3, (TGT ALT) or if time is critical use the average altitude in the target area or the battery altitude.

(3) Store the index grid and altitude in E-3 (TGT STORE).

(4) Enter the grid of the orienting point (decoded from observer's message) in C-1 (OBS EAST) and C-2 (OBS NORTH).

(5) Determine the azimuth of the thrust line (from index to orienting point).

(a) Select D-2 (ORIENT), SM and ENTER.

(b) Add or subtract 3200 as appropriate to convert the resulting back azimuth to the azimuth of the thrust line.

(6) Recall the index point by activating A-4 (TGT RECALL).

(7) Enter the azimuth of the thrust line in A-5 (OT DIR).

(8) From the template, determine the lateral deviation of the target from the index point in relation to the thrust line. Targets to the right of the thrust line have a right deviation. Targets to the left of the thrust line, a left deviation. Enter the lateral deviation as a left or right in A-6 (RIGHT/LEFT).

(9) Enter the range shift from the index point in A-7 (ADD/DROP). The value is always plus.

(10) Depress the COMPUTE button, allow the COMPUTE light to burn for 2 or 3 seconds and then depress the RESET button.

(11) Store the grid and altitude in E-3 (TGT STORE).

(12) Without giving end of mission, recall the index point in A-4. Repeat the same procedure by entering deviation and range shifts from the index point along the thrust line for each target.

(13) Refine the altitude of each target from the situation map as time permits.

Note. These procedures can be used with any FADAC revision program.

c. Record current firing data for all planned targets on an acetate-covered chart similar to the one shown below.

9-12. Solution of a Ballistic Met Message.

To speed up the solution of a ballistic met message:

a. The requirement to interpolate for complementary range (Table B, TFT) has been eliminated. The user simply enters table B with the range and height of target above gun to the nearest 100 meters and extracts the appropriate comp range.

b. Table E of the TFT can be expanded (precomputed) to list the change to MV due to propellant temperature for each degree of temperature from -40°F to +130°F (fig 9-5). This will eliminate the requirement to interpolate each time a met is solved.

Tgt	Grid/Alt	Pieces	Priority	Cht Rg	Cht Df	Shell	Chg	Fz	Ti	Df	QE
121	673365/392	R	X	7240	3190	HE	6	VT	21.0	3197	274
122	693390/417	BTRY		10340	3287	HE&WP	7	VT	29.0	3294	341
123	679372/404	L	X	8110	3231	SMK	6	VT	23.0	3240	324

Firing Data Chart for Planned Targets

	0	1	2	3	4	5	6	7	8	9
-40	-6.9	-6.4	-6.4	-6.5	-6.5	-6.6	-6.7	-6.7	-6.8	-6.8
-30	-6.3	-6.4	-6.4	-6.5	-6.5	-6.6	-6.7	-6.7	-6.8	-6.8
-20	-5.7	-5.8	-5.8	-5.9	-5.9	-6.0	-6.1	-6.1	-6.2	-6.2
-10	-5.0	-5.1	-5.1	-5.2	-5.3	-5.3	-5.4	-5.5	-5.6	-5.6
0	-4.4	-4.5	-4.6	-4.6	-4.6	-4.7	-4.8	-4.8	-4.9	-4.9
10	-3.8	-3.7	-3.7	-3.6	-3.5	-3.4	-3.4	-3.3	-3.2	-3.2
20	-3.1	-3.0	-3.0	-2.9	-2.9	-2.8	-2.7	-2.7	-2.6	-2.6
30	-2.5	-2.4	-2.4	-2.3	-2.3	-2.2	-2.1	-2.1	-2.0	-2.0
40	-1.9	-1.8	-1.8	-1.7	-1.7	-1.6	-1.5	-1.5	-1.4	-1.4
50	-1.3	-1.2	-1.2	-1.1	-1.0	-0.9	-0.9	-0.8	-0.7	-0.7
60	-0.6	-0.5	-0.5	-0.4	-0.4	-0.3	-0.2	-0.2	-0.1	-0.1
70	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5
80	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.2
90	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8
100	1.9	2.0	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.4
110	2.5	2.6	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.0
120	3.1	3.2	3.2	3.2	3.3	3.4	3.5	3.6	3.7	3.7
130	3.8									

Figure 9-5. Supplement to table E FT 155-AM-1 charge 2.

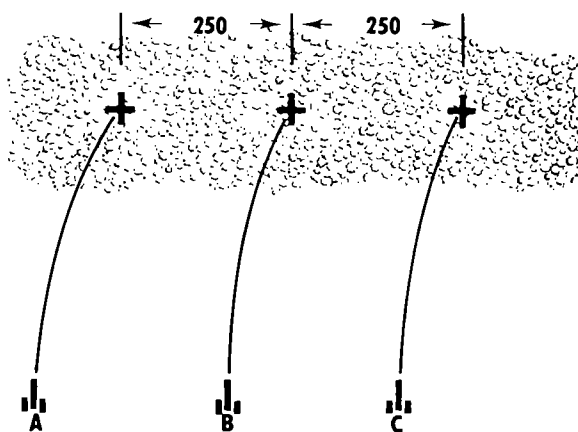
Section II. BATTALION FDC PROCEDURES

9-13. Large Targets

When engaging large targets, fires should be planned to cover the entire target area. Batteries should not all fire at the same point.

BATTERY SHEAF WIDTH AND DEPTH	
105mm	150 × 100
155mm	250 × 100
8-inch	240 × 100
175mm	280 × 100

To attack the 700 × 300 meter target shown to the right with a 155mm battalion, batteries should fire at points generally 250 meters apart. To achieve the desired depth, batteries must fire zone fire or use additional aim points.



9-14. Mass Fire Missions

a. General.

(1) *THE FIELD ARTILLERY CAN ACHIEVE ITS GREATEST KILLING EFFECT ON THE ENEMY BY RAPID MASSING OF FIRES.* Successive volleys from the same weapons give the enemy time to react and seek greater protection; thus massed fire from many weapons is the most effective method of engaging personnel and equipment that can rapidly seek protective cover. The ability of the field artillery to mass fires quickly provides the maneuver commander a key element of success on the modern battlefield--overwhelming combat power brought to bear when and where it's needed.

(2) Mass fire missions may be initiated by:

(a) Higher headquarters (e.g., Division Artillery).

(b) An observer or fire support officer. He may submit his call for fire to the battery FDC or directly to the battalion FDC.

(c) A battery requesting additional fires.

(d) The battalion FDO. He may decide to mass the fires of the battalion after monitoring a call for fire on a lucrative target.

(3) All technical fire direction for mass missions is normally conducted at battery level. This means that in a battalion mass mission each battery computes its own firing data. The battalion FDC acts in a coordinating and control capacity; i.e., it manages the conduct of the mission. The battalion FDO will control the time of opening fire in one of three ways:

(a) Time on target (TOT). This technique is designed to have all rounds *land simultaneously*. *THE TOT IS THE MOST DESIRABLE MEANS OF MASSING FIRE--* it gains the full value of the element of surprise. TOT's are the most effective means of opening fire but also require the most coordination. TOT's are, for the most part, a waste of time when a lengthy adjustment has been conducted.

■ The TOT may be announced as a specific time (e.g., TOT 0915). The battalion FDO announces a time check (e.g., TIME IS NOW 0908) in order to synchronize batteries designated to fire. Each battery controls its own firing, commanding its weapons to fire at "TF + 2 seconds."

■ Another technique to execute a TOT is to specify the amount of time before it is to occur (e.g., TOT 5 MINUTES FROM . . . NOW). Each battery FDC starts its stop watches at . . . "NOW". From that moment, each battery FDC controls its own firing, commanding its weapons to fire at "TF + 2 seconds."

■ A third technique (preferred) for execution of a TOT is to determine the time to begin a short countdown based on the longest time of flight of the designated batteries to fire. After each battery reports ready and time of flight, the battalion FDO adds 10-15 seconds to the longest time of flight, expressing to the nearest 10 seconds. He then announces, TOT . . . (SO MANY) SECONDS FROM . . . NOW. Each battery FDC starts its stop watch at . . . "NOW". From that moment each battery FDC controls its own firing, commanding its weapons to fire at "TF + 2 seconds."

(b) At my command. Here the Bn FDO has all units firing simultaneously. By doing this, the FDO is willing to accept the loss of surprise caused by varying times of flight. This technique is particularly effective when unit TF's are fairly similar.

(c) When ready. Unless otherwise specified, each battery will fire when ready. This technique is used more often with adjust fire missions (particularly those with lengthy adjustment phases) than with fire-for-effect missions. When surprise has been lost, the differences in reaction times and times of flight between units is probably not significant.

(4) Battalion normally communicates with each participating unit over its (participating unit's) appropriate fire net. When the situation permits, the nonadjusting battery may switch a radio over to the adjusting battery frequency to more easily follow the mission.

b. *Mission submitted directly to the battalion FDC.* When the battalion FDC receives a mission that warrants mass fires, it will alert each appropriate firing unit (to include reinforcing artillery) on its (battery's) FD frequency by transmitting an abbreviated fire mission.

(1) Example - FFE mission.

H53 THIS IS H69,
FIRE FOR EFFECT, BATTALION,
OVER.

GRID 61348982, ALTITUDE 430,
OVER.

ICM, 2 ROUNDS, TIME ON TARGET
7 MINUTES FROM . . . NOW,
OVER.

(2) Example - AF mission.

H53, THIS IS H69, ADJUST FIRE,
BATTALION, BRAVO, OVER.

GRID 516391, ALTITUDE 510, OVER.

VT IN EFFECT, 2 ROUNDS, OVER.

DIRECTION 4160, OVER.

Note. "ADJUST FIRE, BATTALION, BRAVO" in the call for fire indicates that this is a battalion adjust fire mission with Bravo battery as the adjusting battery. Nonadjusting batteries will follow the mission and compute data.

c. *Mission submitted to the battery FDC.* Battalion monitors the call for fire (CFF) or battery readback of it. (Mass fires are initiated based on a request by the battery for additional fires or based on the battalion FDO's decision after monitoring the call for fire.)

The FDO must quickly decide whether or not to step in. Any delay increases the chance that the battery will act independently. For example, in a fire for effect mission on a planned target, surprise may be lost if the battery fires one volley before the FDO decides to mass the battalion.

(1) Battalion FDC will inform the battery FDC receiving the mission how the mission will be fired by issuing a fire order over the appropriate fire net; e.g., BATTALION BRAVO, 2 ROUNDS, VT IN EFFECT, OVER.

(2) Batteries not receiving (directly) the fire mission will be alerted as in b above.

d. *Subsequent corrections.* Subsequent corrections are normally sent to the appropriate FDCs by battalion as they are submitted by the FO.

e. *Examples.*

(1) A fire-for-effect mission is received in the battalion FDC from division artillery. The grid location of the target is 437295. The target altitude is 370 meters. The mass fire mission would be conducted over FM radio as follows:

Battalion FDC

(a) (Concurrently)

A Computer (to battery) on F1:

D12, THIS IS H12, FIRE FOR
EFFECT, BATTALION, OVER.

B Computer (to battery) on F2:

E12, THIS IS H12, FIRE FOR
EFFECT, BATTALION, OVER.

C Computer (to battery) on F3:

F12, THIS IS H12, FIRE FOR
EFFECT, BATTALION, OVER.

(b) (Concurrently)

A Computer:
B Computer:
C Computer:

GRID 437295,
ALTITUDE 370,
OVER.

(c) (Concurrently)

A Computer:
B Computer:
C Computer:

ICM, 3 ROUNDS,
RANGE SPREAD,
TIME ON TARGET,
OVER.

A Computer:
B Computer:
C Computer:

I AUTHENTICATE
***, OUT.

Note. By unit SOP "B" fires on the announced grid, "A" fires 100 meters short, and "C" fires 100 meters beyond.

Battery FDC's

A Btry:

H12, THIS IS D12, FIRE FOR
EFFECT, BATTALION,
OUT.

B Btry:

H12, THIS IS E12, FIRE FOR
EFFECT, BATTALION,
OUT.

C Btry:

H12, THIS IS F12, FIRE FOR
EFFECT, BATTALION,
OUT.

A Btry:
B Btry:
C Btry:

GRID 437295, ALTITUDE
370, OUT.

A Btry:
B Btry:
C Btry:

ICM, 3 ROUNDS, RANGE
SPREAD, TIME ON TAR-
GET, AUTHENTICATE, ***
***, OVER.

***EACH COMPUTER AT BATTALION
WOULD ANSWER THE SEPARATE
CHALLENGE OF HIS RESPECTIVE
BATTERY FDC.

Battalion FDC

(d) (When Ready)

B Computer:
C Computer:
A Computer:

THIS IS H12,
ROGER, OUT.

(e) (Concurrently)

A Computer:
B Computer:
C Computer:

THIS IS H12, TOT
40 SECONDS
FROM - - - NOW.

Battery FDC

B Btry:

THIS IS E12, READY, TF 28,
OVER.

C Btry:

THIS IS F12, READY, TF 19,
OVER.

A Btry:

THIS IS D12, READY, TF 25,
OVER.

C Btry:

THIS IS F12, ROGER, OUT.

B Btry:

THIS IS E12, ROGER, OUT.

A Btry:

THIS IS D12, ROGER, OUT.

(f) Each battery controls its own firing. The remainder of the mission, e.g., "SHOT", "ROUNDS COMPLETE", is as normal.

(2) An adjust fire mission is received in the A battery FDC. The mass fire mission would be conducted over FM radio as follows: (Only one nonadjusting element is shown. Additional nonadjusting elements would be handled in a similar manner.)

ObserverBattery FDCBattalion FDC

FO (to Btry A) on F1:

D12, THIS IS D19,
ADJUST FIRE,
SHIFT 107, OVER.

FO (to A Btry):

DIRECTION 400,
LEFT 200, ADD 500,
OVER.

FO (to A Btry):

COMPANY
ASSEMBLY AREA,
ICM IN EFFECT,
OVER.

FO (to A Btry):

I AUTHENTICATE
SIERRA, OUT.

A Btry (to FO):

D19, THIS IS D12,
ADJUST FIRE,
SHIFT 107, OUT.

A Btry (to FO):

DIRECTION 400,
LEFT 200, ADD 500,
OUT.

A Btry (to FO):

COMPANY ASSEM-
BLY AREA, ICM IN
EFFECT, AUTHEN-
TICATE ECHO
BRAVO, OVER.

Bn FDO: (to A Btry)
on F1:

D12. THIS IS H12, I
MONITORED D19,
BATTALION,
ALFA, 3 ROUNDS,
OVER.

A Btry (to Bn):

THIS IS D12, BAT-
TALION, ALFA, 3
ROUNDS, OUT.

Observer

Battery FDC

Battalion FDC

A Btry (to FO):

FO (to A Btry):

BATTALION,
ALFA, 3 ROUNDS,
OVER.

BATTALION,
ALFA, 3 ROUNDS,
OUT.

B Computer (to B
Btry) on F2:

B Btry (to Bn):

E12, THIS IS H12,
ADJUST FIRE,
BATTALION,
ALFA, SHIFT 107,
OVER.

THIS IS E12,
ADJUST FIRE,
BATTALION,
ALFA, SHIFT 107,
OUT.

B Computer (to B
Btry):

DIRECTION 400,
LEFT 200, ADD
500, OVER.

B Btry (to Bn):

DIRECTION 400,
LEFT 200, ADD
500, OUT.

B Computer (to B
Btry):

ICM IN EFFECT,
3 ROUNDS, OVER.

B Btry (to Bn):

ICM IN EFFECT,
3 ROUNDS, OUT.

A Btry (to FO):

SHOT, OVER.

ObserverBattery FDCBattalion FDC

FO (to A Btry):

SHOT OUT.

FO (to A Btry):

LEFT 100, ADD 400,
FIRE FOR
EFFECT, OVER.

A Btry (to FO):

LEFT 100, ADD 400,
FIRE FOR
EFFECT, OUT.

A Btry (to Bn):

THIS IS D12, AT
MY COMMAND,
OUT.A Computer (to A
Btry):THIS IS H12, AT
MY COMMAND*,
OVER.

*The battalion FDO has decided that since the adjustment was very short, surprise may not have been lost. He wants all rounds to impact at approximately the same time to maximize effect.

B Computer (to B
Btry):

B Btry (to Bn):

THIS IS E12, LEFT
100, ADD 400, AT
MY COMMAND,
FIRE FOR
EFFECT, OUT.THIS IS H12, LEFT
100, ADD 400, AT
MY COMMAND,
FIRE FOR
EFFECT, OVER.

Observer

Battery FDC

Battalion FDC

B Btry:

THIS IS E12,
READY, OVER.

B Computer:

ROGER, OUT.

A Btry:

THIS IS D12,
READY, OVER.

A Computer:

ROGER, OUT.

B Computer:

A Computer:

B Btry:

THIS IS E12,
FIRE, OUT.

THIS IS H12,
FIRE, OVER.

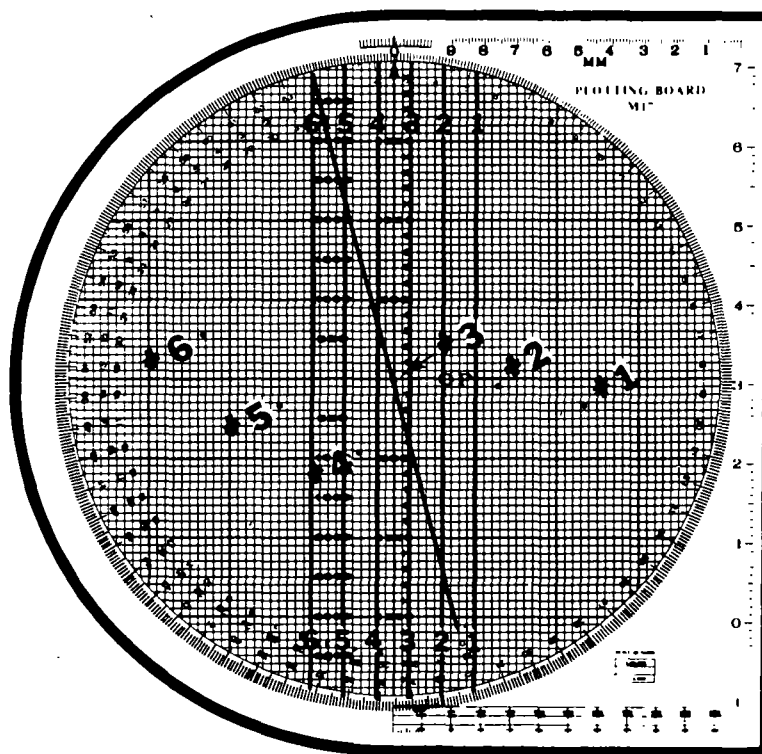
A Btry:

THIS IS D12,
FIRE, OUT.

This example now proceeds as did example 1. Each nonadjusting battery reports "SHOT" and "ROUNDS COMPLETE" to battalion. Battalion then reports to the adjusting battery. The adjusting battery will notify the FO when the first and last rounds of the battalion have been fired.

CHAPTER 10

TERRAIN GUN POSITION CORRECTIONS



CHAPTER 10

TERRAIN GUN POSITION CORRECTIONS

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Section I: INTRODUCTION

10-1. General

a. Survivability on the modern battlefield dictates the maximum possible use of cover and concealment in positioning field artillery. When pieces are positioned to take advantage of the terrain available rather than to fit a precise geometric formation (lazy W, star), corrections may be required to compensate for that positioning; i.e., to obtain an acceptable sheaf (burst pattern) in the target area. At the same time, these corrections should compensate for the difference in muzzle velocity (MV) between pieces.

b. To *ACCURATELY* obtain the desired burst pattern (disregarding dispersion), the corrections should be computed for each particular mission. Each mission then becomes a special corrections mission. This is an operationally unacceptable procedure - it is totally unresponsive and far too complicated. To be responsive, corrections must be precomputed and sent to the firing battery well in advance of the mission. Then when a mission is received, the FDC computes and transmits one set of firing data to the pieces and piece corrections carried on the guns compensate for positioning and differences in MV. Only in this way can responsive fire support be maintained.

c. Terrain gun position corrections (TGPC) are the precomputed corrections carried at the firing battery to compensate for terrain positioning and muzzle velocity differences.

d. When TGPC are being used, trajectories will often cross. For example, the leftmost piece in the battery area along the azimuth of fire may not provide the leftmost burst in the target area. The FDO must be aware of this fact when the exact positioning of each piece's burst is required; e.g., firing a range spread. In this case, consideration should be given to cancelling the TGPC for the mission and applying special corrections.

10-2. Transfer Limits

a. TGPC are most accurate at the ranges and in the directions for which they were computed. TGPC may be considered valid

2000 METERS OVER AND SHORT of the range and *400 MILS LEFT AND RIGHT* of the azimuth used in computing the corrections.

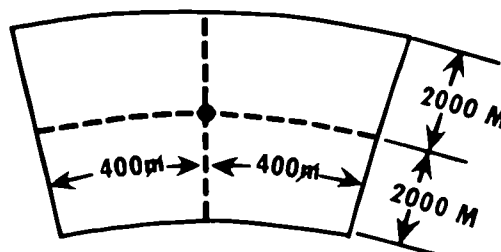


Figure 10-1. TGPC transfer limits.

b. The amount you can transfer the TGPC really depends on how spread out your battery is. TGPC will provide acceptable effect on the target (within the transfer limits stated above) provided the battery position is within a box *400M WIDE AND 200M DEEP*. This box is centered over the battery center (BC) and oriented perpendicular to the azimuth of lay (fig 10-2). If your battery is more spread out than this, you'll have less effect on the target within the stated transfer limits.

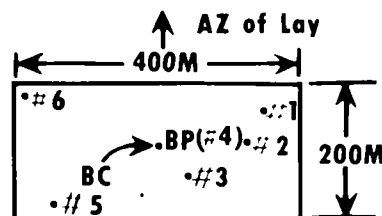


Figure 10-2. Battery position.

**THE LARGER THE POSITION AREA,
THE SMALLER THE TRANSFER
LIMITS.**

Generally speaking, try to place all pieces within the 400 x 200M box. Remember, with this size position, TGPC transfer limits are:

***2000 METERS OVER AND SHORT
OF THE RANGE--
*400 MILS LEFT AND RIGHT OF THE
AZIMUTH--
--USED IN THE COMPUTATIONS.**

10-3. Sectors of Fire

a. Since a battery's area of responsibility may be larger than the area within transfer limits, a battery should compute terrain gun position corrections for each of three sectors--left, primary, and right (fig 10-3). Ranges to the centers of the left and right sectors may be different from those to the center of the primary sector; for example, the sectors may be configured to conform to the maneuver unit control measures.

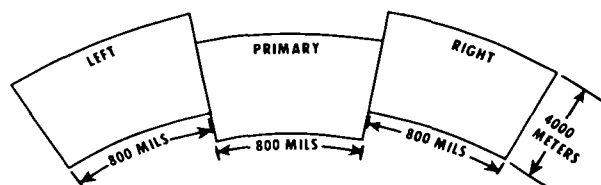


Figure 10-3. Left, primary, and right sectors.

b. The "Special Instructions" element of the fire commands will indicate which sector's TGPC the firing battery is to use for the mission if other than the primary sector. *THE PRIMARY SECTOR CORRECTIONS WILL NORMALLY BE CARRIED ON ALL GUNS UNLESS INSTRUCTIONS TO THE CONTRARY ARE GIVEN.* The command *LEFT SECTOR* in the special instructions element will indicate that corrections for the left sector are to be set off; the command *RIGHT SECTOR*, corrections for the right sector. The command *CANCEL TERRAIN CORRECTIONS* will indicate that all corrections counters are to be zeroed for the mission. Absence of any instruction in the fire mission will then indicate that corrections for the primary sector will be fired.

c. There will be times when computing TGPC for the three recommended sectors will not be adequate. For example, a reinforcing unit with the primary mission of counterfire may require more than a 4,000 meter range band in a particular sector. In this case you may desire to compute TGPC for two or three different range bands. If so, insure that you establish a means of identifying when the

firing battery is to use these additional (i.e., other than left, primary, right) TGPC.

d. If a mission is to be fired into an area for which no TGPC are computed, you have a number of options available:

(1) Fire parallel sheaf. The smaller the position area, the better this solution.

(2) Fire the computed TGPC for the sector closest to the target.

(3) Mass fires by platoon or by piece. This will normally be done with FADAC but if platoons (pieces) are widely dispersed, the firing chart/manual solution can be used.

(4) Use deflection difference (para 9-10b) or hasty TGPC (para 10-15).

(5) Compute special corrections (time consuming).

10-4. Computation of TGPC

a. To compute TGPC you must first know the piece displacement of each weapon. The large areas normally associated with terrain positioning complicate the determination of displacement. To simplify this determination, a graphical solution employing the M10/M17 plotting board is used (see section II below).

b. Once displacements (for a given azimuth) have been determined, corrections for a TGPC sector can be computed on the reverse side of the Record of Fire. TGPC computations are presented in a step-by-step format. The data required for the computations are:

- (1) Piece displacement.
- (2) 4,000 meter range segment.
- (3) Charge(s) to be fired.
- (4) Piece MV's.

Section II. HASTY TRAVERSE—THE DETERMINATION OF PIECE DISPLACEMENT

10-5. General

a. The practice of estimating piece displacement or determining displacement by pacing (at right angles-left/right, forward/behind) is normally not sufficiently accurate for the large distances encountered in terrain positioning. The hasty traverse technique is intended as a quick, accurate means of determining piece displacement.

b. The hasty traverse technique is a graphical solution of piece displacement which uses the M10/M17 plotting board. The data required to determine displacement using the hasty traverse are the distance from each weapon to the aiming circle (AC) and the final deflection announced in laying each weapon (lay deflection).

c. The first step is to plot each piece on the plotting board. Then by orienting the transparent disk along a given azimuth, displacement

with respect to that azimuth can be determined.

10-6. Determination of Distance

Determine the distances required for the hasty traverse by--

a. *Straight-line pacing.* Each section provides a man (with a known pace) to pace the distance to the aiming circle. The pacer is kept on a straight-line course by the gunner through his panoramic telescope.

Note. Because of its simplicity, straight-line pacing is normally the preferred technique.

b. *Subtense.* For TGPC computations the 2-meter rod (subtense bar) is used. Distances up to 250 meters can be measured to within a fraction of a meter using the 2-meter rod (table 10-1). For details on the use of subtense, see FM 6-50.

Table 10-1. Subtense data.

To be used with 2 meter subtense rod. Angles in mils, distances in meters

ANGLE	DIST	ANGLE	DIST	ANGLE	DIST	ANGLE	DIST	ANGLE	DIST	ANGLE	DIST
7.0	291.03	14.0	145.51	21.0	97.01	28.0	72.75	35.0	58.20	42.0	48.50
.2	280.99	.2	142.96	.2	95.86	.2	72.11	.2	57.97	.2	48.21
.5	271.62	.5	140.49	.5	94.75	.5	71.48	.5	57.38	.5	47.93
.8	262.86	.8	137.65	.8	93.66	.8	70.85	.8	56.98	.8	47.65
8.0	254.65	15.0	135.81	22.0	92.60	29.0	70.24	36.0	56.58	43.0	47.37
.2	246.93	.2	133.58	.2	91.56	.2	69.64	.2	56.19	.2	47.10
.5	239.67	.5	131.42	.5	90.54	.5	69.05	.5	55.81	.5	46.82
.8	231.50	.8	129.34	.8	89.54	.8	68.47	.8	55.43	.8	46.56
9.0	226.35	16.0	127.32	23.0	88.57	30.0	67.90	37.0	55.05	44.0	46.29
.2	220.23	.2	125.36	.2	87.62	.2	67.34	.2	54.68	.2	46.08
.5	214.44	.5	123.46	.5	86.68	.5	66.79	.5	54.32	.5	45.77
.8	208.94	.8	121.62	.8	85.77	.8	66.24	.8	53.96	.8	45.47
10.0	203.72	17.0	119.83	24.0	84.88	31.0	65.71	38.0	53.60	45.0	45.26
.2	198.75	.2	118.09	.2	84.00	.2	65.18	.2	53.25		
.5	194.02	.5	116.41	.5	83.15	.5	64.67	.5	52.91		
.8	188.63	.8	114.77	.8	82.31	.8	64.16	.8	52.57		
11.0	185.20	18.0	113.17	25.0	81.48	32.0	63.66	39.0	52.23		
.2	181.08	.2	111.62	.2	80.68	.2	63.16	.2	51.90		
.5	177.14	.5	110.11	.5	79.89	.5	62.68	.5	51.57		
.8	173.38	.8	108.65	.8	79.11	.8	62.20	.8	51.24		
12.0	169.76	19.0	107.22	26.0	78.35	33.0	61.73	40.0	50.92		
.2	166.30	.2	105.82	.2	77.60	.2	61.26	.2	50.67		
.5	162.97	.5	104.47	.5	76.87	.5	60.81	.5	50.29		
.8	159.78	.8	103.15	.8	76.15	.8	60.36	.8	49.99		
13.0	156.70	20.0	101.86	27.0	75.45	34.0	59.91	41.0	49.68		
.2	153.75	.2	100.60	.2	74.75	.2	59.47	.2	49.38		
.5	150.90	.5	99.37	.5	74.07	.5	59.04	.5	49.08		
.8	148.16	.8	98.17	.8	73.41	.8	58.62	.8	48.79		

10-7. Determination of Direction

a. The final lay deflection to each piece is used - that is, no special referring/sighting is required to determine displacement.

b. To prepare the plotting board for use, (see fig 10-4) set off the azimuth of lay by rotating the transparent disk until that azimuth is over the red arrow on the gridded base. *THE OUTER (BLACK) SCALE IS USED.* With a pencil or pen, place an index on the base of the plotting board opposite the zero on the outer (black) scale - this is your TGPC index.

c. Orient the plotting board by rotating the transparent disk until the lay deflection (outer black numbers) for a given piece is opposite the TGPC index. The red arrow on the board will then be oriented in the direction from the aiming circle to the piece. *THIS ACTION PERTAINS TO M100 SERIES SIGHTS. FOR A DISCUSSION OF M12 SERIES SIGHTS, SEE APPENDIX E.*

a. *Plotting the aiming circle.* To orient the board in the direction from the base piece to the AC, rotate the transparent disk until the base piece LAY DF + 3200 is opposite the TGPC index. This is simply orienting the board along the back azimuth of the direction from the AC to the base piece (para 10-7). Place a small dot along the red arrow at the distance the AC is from the base piece (each small square represents 10 meters). Label the dot AC for aiming circle.

b. *Plotting the piece.* After plotting the AC, reorient the disk so that the deflection from the aiming circle to the piece in question is over the TGPC index. The AC is now on a line, real or visualized, parallel to the red arrow which is now oriented in the direction from the AC to the piece. (Any line parallel to the red arrow is oriented in the same direction as the red arrow.) Place a dot on this line (toward the top of the board) at the distance from the AC to the piece and label the dot with the piece number. Repeat this procedure for the remaining pieces.

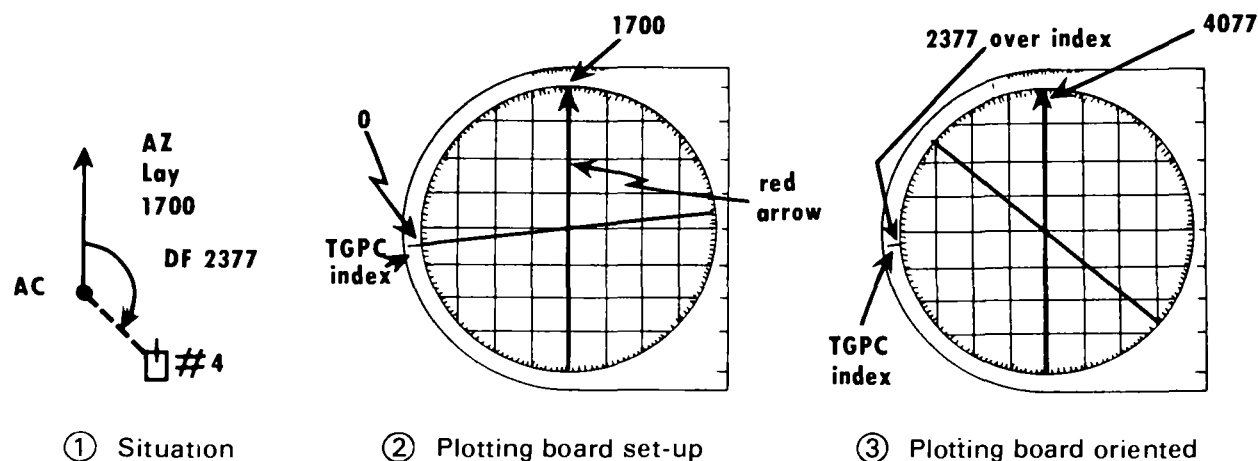


Figure 10-4. Setup and orientation of the plotting board.

10-8. Determination of Displacement

The center of the plotting board represents the battery center and, therefore, the location of the base piece. Before the displacement of any piece (other than base piece) can be determined, the AC must be plotted in relation to the battery center. Then the piece in question must be plotted in relation to the AC.

c. *Determining the displacement.* Reorient the transparent disk so that the azimuth of lay is over the red arrow. (The outer black 0 should be over the TGPC index.) The piece displacement from the battery center with respect to the azimuth of lay is the number of meters that the dot representing the piece is right or left of the red arrow and forward or behind the center horizontal line of the plotting board.

d. Example.

(1) Given (fig 10-5).

-155mm howitzer M109A1.

-Azimuth of lay is 1,300 mils.

-Aiming circle to base piece:

Distance is 115 meters;

deflection is 2752 mils.

-Aiming circle to piece 5:

Distance is 165 meters;

deflection is 3455 mils.

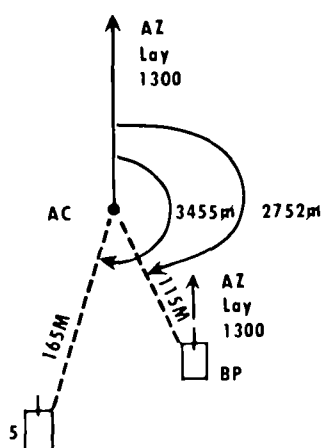
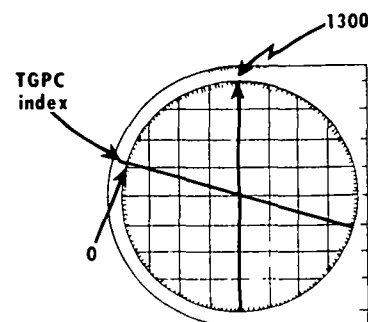


Figure 10-5. Example layout.

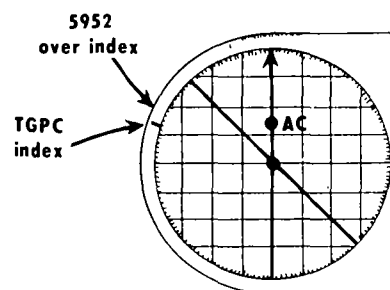
(2) Required. Displacement of piece 5 from battery center with respect to the azimuth of lay.

(3) Solution. Rotate the transparent disk until 1300 (azimuth of lay) is over the red arrow. Place the TGPC index opposite the black (outer) zero (① fig 10-6). The deflection from the AC to the base piece is 2752 mils. To locate the AC on the plotting board rotate the transparent disk so that deflection 5952 (2752 + 3200) is over the TGPC index (② fig 10-6). Place a dot along the arrow 115 meters from the battery center. This is the location of the aiming circle. The deflection from the AC to the piece is 3455 mils. Reorient the transparent disk so that 3455 is over the TGPC index (③ fig 10-6). Along a visualized line parallel to the red arrow and extending from the AC toward the top of the board,

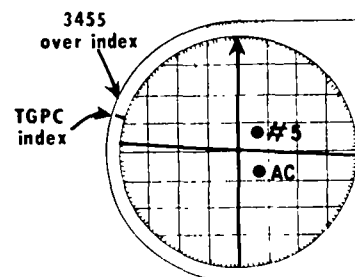
place a dot 165 meters from the AC. Label this dot 5. Reorient the transparent disk so that the azimuth of lay (1300) is over the red arrow (black outer 0 is over TGPC index). Note that with respect to the azimuth of lay, piece 5 is displaced 90 meters left of and 55 meters behind the battery center.



① Construct index



② Plot AC



③ Plot piece

Figure 10-6. Plotting the piece.

10-9. Sequence for Determination of Displacement

In determining displacements for an entire battery, use the following sequence:

a. Plot the AC using the base piece lay deflection and the distance from the base piece to the AC.

b. Plot all pieces using the AC and appropriate deflections and distances.

c. Orient the disk on the azimuth of lay. Piece displacement can now be read for all pieces.

d. To determine piece displacement for the left and right sectors, orient the disk on the azimuth to the center of the appropriate sector. Displacement can then be read for each piece.

REMEMBER - PIECE DISPLACEMENTS MUST BE RECOMPUTED FOR EACH SECTOR.

10-10. Determination of Piece Displacement by the Reconnaissance Party

a. Whenever possible, the recon party should determine piece displacement. This will save time by eliminating the requirement

to determine displacement after the battery occupies the position. Having the recon party determine the displacement will also allow precomputation of TGPC (by Battery Operations Center (BOC) personnel).

b. The recon party should set the aiming circle up:

(1) Over BC and measure the directions to the piece locations directly or--

(2) Over the orienting station (if survey is available) or at an appropriate location for laying the battery. Determine an initial deflection to each piece location and proceed as discussed in para 10-7 and 10-8.

c. Distance will be determined by having each section guide pace to the appropriate station (battery center or aiming circle).

d. BOC personnel should compute displacement using the M10/M17 plotting board as discussed earlier.

Note. For directions and distances measured from battery center simply orient the plotting board in the direction (black outer scale) from BC to the piece and mark off the appropriate distance. This is done for each piece. Reorient the disk along the azimuth of lay and determine displacement.

Section III. TGPC COMPUTATIONS

10-11. Computation of Terrain Gun Position Corrections

Compute terrain gun position corrections by using the M10/M17 plotting board and the *SPECIAL CORRECTIONS FOR TERRAIN GUN POSITION* section on the back of the Record of Fire. Use one form for each sector. The computational procedure is as follows:

a. In the *TRANSFER LIMITS* block, circle the sector for which corrections are to be computed, record the azimuths and deflections to the left and right limits (400 mils left and right) of the sector, and record the minimum and maximum ranges and the charge(s) to be fired. Record battery comparative VE's in col-

umn ⑥. (Record plus VE's as increases (I) and minus VE's as decreases (D) from that of the base piece. Do not enter plus and minus signs.)

b. Remove the transparent disk from the plotting board, and using the center of the base as the BC, draw vertical lines (burst lines) corresponding to the desired sheaf (one small grid = 10 meters) (fig 10-7). The placement of the burst lines depends upon weapon caliber and can be predrawn on the plotting board. Normal sheaf widths are reduced for TGPC computations to compensate for the widening that occurs as the sheaf is moved away from the center of a sector. Desired widths are shown on the top of the next page.

Weapon	Desired sheaf width (M)
105mm	100
155mm	200
8-inch	180
175mm	180

These widths result in the desired distances from target center shown in table 10-2. Burst line 1 is on the right; burst line 2 is second from the right; and so on.

Table 10-2. Burst line lateral displacement.

Desired distance from battery center.

Burst line	No 1	No 2	No 3	No 4	No 5	No 6
105 Btry	50R	30R	10R	10L	30L	50L
155 Btry	100R	60R	20R	20L	60L	100L
8" Btry	90R	30R	30L	90L		
175 Btry	90R	30R	30L	90L		

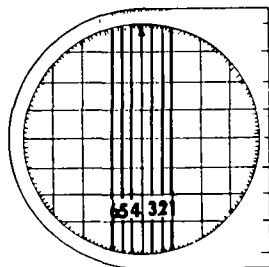


Figure 10-7. Plotting board with burst lines.

c. Replace the disk and plot individual piece locations. For the primary sector, orient the disk so that the azimuth of lay is over the red arrow. For the left or right sector, orient the disk so that the azimuth to the center of the sector is over the red arrow.

d. Determine the burst line to which each piece corrects. The right piece in relation to the line of fire (red arrow) will be corrected to the right burst line; the second gun from the right in relation to the line of fire will be corrected to the second burst line from the right; and so on until all pieces have been corrected. (Piece 1 does not necessarily correct to burst line 1, piece 2 to burst line 2, etc.) In the Dir of Corr column, record the burst line number (1 on the right, 2 second from right, etc.) and whether the correction is toward (T) or away from (A) battery center. Knowing T or A we can select the proper 100/R value. Record the

lateral displacement from BC in column ① and the position range correction (piece displacement with appropriate sign) in column ⑨ (both to the nearest 5 meters). If the piece is forward, the correction is minus; if behind, the correction is plus.

Note. TGPC are designed to provide a standard sheaf on line (see table 10-2).

e. Enter table F of the TFT with the range to the center of the sector expressed to the nearest 100 meters. Extract the muzzle velocity unit corrections for both decrease and increase and record the corrections in the heading of column ⑦. Extract the range change per mil factor and record it in the heading of column ⑪.

f. Using a GFT, determine 100/R values for the minimum and maximum ranges and record them in the heading of column ④. *THE MAXIMUM 100/R VALUE USED IS 25; THEREFORE, IF 100/R IS LARGER THAN 25, ENTER 25 ON THE MIN RG LINE.* Note that different 100/R values will be used depending on whether the piece corrects toward or away from battery center. The logic behind this is that:

(1) For pieces correcting away from BC, the greater the range fired, the further away from the center of the sheaf the burst will land. If the 100/R value for the mid range is used, at the maximum range the burst may fall an unacceptably large distance away from the center of the sheaf. To insure a satisfactory sheaf at the maximum range we accept a smaller (than necessary) outward correction at the lesser ranges.

(2) For pieces correcting toward BC, an insufficient correction may result at the minimum range, if the mid-range 100/R value is used. To achieve a satisfactory sheaf at the minimum range, the maximum value is used and crossing of sheafs is accepted. A maximum 100/R value of 25 has been selected since test and evaluation have indicated TGPC validity breaks down when larger values are used.

g. From table 10-2, determine the desired lateral displacements and record them in col-

umn ②. Enter the magnitude and direction of the correction required in column ③ ($② - ① = ③$ or measure directly from the plotting board by using the burst lines). Enter the appropriate 100/R value in column ④ (depending on whether the correction is toward or away from battery center) and perform the multiplication indicated in the heading for column ⑤. Label the position deflection correction L (for left) or R (for right); express the corrections to the nearest mil.

h. Enter the appropriate MV unit correction in column ⑦. Multiply the values in column ⑥ and column ⑦ and enter the product, expressed to the nearest meter, in column ⑧. The value in column ⑧ should have the same sign as that in column ⑦. Add the values in column ⑧ and column ⑨ and enter the sum in column ⑩. Divide the value in column ⑩ by the value in column ⑪ and enter the quotient, expressed to the nearest mil, in column ⑫. The quadrant elevation correction in column ⑫ should have the same sign as the value in column ⑩.

i. The appropriate deflection correction (column ⑤) and elevation correction (column ⑫) are sent to each gun as its TGPC for the primary sector.

j. To determine a fuze setting correction for a piece:

(1) Determine the fuze setting for the center range; i.e., base piece range.

(2) Add the total TGPC range correction (column ⑩) for the piece (expressed to the nearest 10 meters) to the center range.

(3) Determine the fuze setting for the corrected range determined in (2) above.

(4) Subtract the fuze setting in (1) above from the fuze setting in (3) above. This is the fuze setting correction for the piece.

k. For the left and right sectors, repeat the procedures in a through j above, using the azimuth to the center of each sector as the azimuth of fire and the appropriate range bands, charges, and correction factors (they may differ from the primary sector).

10-12. Example — TGPC Computations

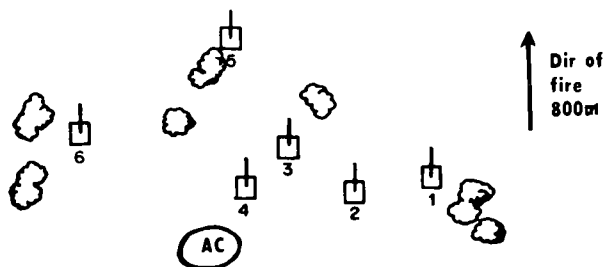


Figure 10-8. Battery position - example.

a. *Situation.* A 155mm M109A1 battery is laid on azimuth 800 (fig 10-8). The center range to be fired is 4900. The BP (#3) is over the BC. The information shown below is furnished to the FDC. Distances were measured by pacing.

Piece	Distance to AC (M)	Lay Deflection (mil)	Comparative VE (M/S)
1	185	1405	+2.7
2	110	1377	-1.7
3	90	0590	0
4	35	0420	+0.7
5	165	0064	+1.6
6	170	5430	-1.9

b. *Requirement.* Determine piece displacements and terrain gun position corrections (including corrections for fuze M564) for charge 4GB for the primary sector.

c. *Solution for the primary sector (fig 10-9).*

(1) In the TRANSFER LIMITS block, circle the appropriate sector (in this case, P), record the charge, the azimuths and deflections for the left and right limits of the primary sector, and the minimum and maximum ranges. Record the comparative VE's in column ⑥ (+VE's as increases (I) and -VE's as decreases (D)).

(2) Determine displacement using the plotting board. Orient the disk so that 800 (azimuth of lay) is over the red arrow. Construct the TGPC index. Rotate the disk so that 3790 (0590 + 3200) is over the TGPC index. Place a dot along the arrow 90 meters from the battery center and label the dot AC. This dot represents the location of the aiming

INDIVIDUALS		Df ±		Fz ±		Rg K ±													
TRANSFER OF GFT SETTING																			
Btry	①	②	③	④	⑤	⑥	⑦												
	Bn BP Comp VE	MV Corr Factor D+ I-	MV Rg Corr	Achieved Rg	Corr Rg	EI ~ ⑤ (Use EI Gogeline)	Ti ~ ⑤ (Use Ti Gogeline)												
	M/S	M	10M	10M	10M	m	FS												
Fuze Settings: <i>Piece</i>																			
<table border="0"> <tr> <td>1</td> <td>-0.1</td> </tr> <tr> <td>2</td> <td>+0.4</td> </tr> <tr> <td>3 (BP)</td> <td>0</td> </tr> <tr> <td>4</td> <td>+0.1</td> </tr> <tr> <td>5</td> <td>-0.5</td> </tr> <tr> <td>6</td> <td>+0.1</td> </tr> </table>								1	-0.1	2	+0.4	3 (BP)	0	4	+0.1	5	-0.5	6	+0.1
1	-0.1																		
2	+0.4																		
3 (BP)	0																		
4	+0.1																		
5	-0.5																		
6	+0.1																		
FS Corr (M564)																			
SPECIAL CORRECTIONS FOR TERRAIN GUN POSITION																			
TRANSFER LIMITS																			
LPR Sector Chg(s) 4GB																			
<table border="0"> <tr> <td>Az (L)</td> <td>0400</td> <td>(R)</td> <td>1200</td> </tr> <tr> <td>Df (L)</td> <td>3600</td> <td>(R)</td> <td>2800</td> </tr> <tr> <td>Rg (Min)</td> <td>2900</td> <td>(Max)</td> <td>6900</td> </tr> </table>								Az (L)	0400	(R)	1200	Df (L)	3600	(R)	2800	Rg (Min)	2900	(Max)	6900
Az (L)	0400	(R)	1200																
Df (L)	3600	(R)	2800																
Rg (Min)	2900	(Max)	6900																
Gun	Corr To Burst Line	Dir Of Corr T=→BC← A=←BC→	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫					
			Lateral Displ From BC (L/R)	Desired Lateral Displ From BC (L/R)	Lateral Corr Required (L/R)	100/R GFT T 25 Min Rg A 15 Max Rg	Pos Df Corr (L/R)	Btry Comp VE	MV Corr Factor (Table F)	MV Rg Corr	Pos Rg Corr	Total Rg Corr	Rg Change Per Mil Factor (Table F)	Pos EI Corr					
#	#	T/A	M	M	M	m	m	M/S	M	M	M	M	M	m					
1	1	T	130R	100R	L30	25	L8	12.7	-20.8	-56	+40	-16	14	-1					
2	2	A	55R	60R	R5	15	R1	11.7	+27.0	+46	+50	+96	14	+7					
3	3	A	0	20R	R20	15	R3	0	0	0	0	0	14	0					
4	4	T	35L	20L	R15	25	R4	10.7	-20.8	-15	+40	+25	14	+2					
5	5	A	40L	60L	L20	15	L3	11.6	-20.8	-33	-95	-128	14	-9					
6	6	T	190L	100L	R90	25	R22	11.9	+27.0	+51	-20	+31	14	+2					

Figure 10-9. Solution for primary sector--example.

*Note. Piece 1 does not always correct to burst line 1, etc.

circle. For each remaining piece (1, 2, 4, 5 and 6), orient the disk so that the lay deflection from the AC is over the TGPC index, mark off the distance from the AC parallel to and in the direction of the arrow, and label the plot. Rotate the disk so that the azimuth of lay (0800) is over the red arrow.

(3) Burst lines 1 through 6 are predrawn on the base of the plotting board. Determine the burst line to which each piece corrects (right piece to the right line, second piece to the second line, etc.) and whether the correction is toward (T) or away (A) from the BC. Record the lateral displacement of each piece from battery center in column ① and the position range correction in column ⑨. Using the range to the center of the sector (4900), enter table F (TFT) for charge 4 GB. Extract the MV unit corrections for decrease (D) and increase (I) and record them in column ⑦. Extract the range change per mil factor and record it in column ⑪. On the GFT, determine 100/R for the minimum and maximum ranges and record in the heading of column ④. For range 2900, 100/R = 35 (greater than 25); enter 25. Enter the appropriate values in column ④, depending on whether corrections are toward or away from

the battery center. Computations can now be completed to determine the position deflection corrections and the position elevation corrections, and the M564 fuze corrections.

d. For the left and right sectors rotate the transparent disk until the azimuth to the center of the appropriate sector is over the red arrow. **RECOMPUTE PIECE DISPLACEMENTS - THEY ARE DIFFERENT FOR EACH SECTOR.**

10-13. Second Aiming Circle

When occupying widely dispersed position areas, two aiming circles may be required to lay the battery.

a. If both aiming circles are visible from the base piece, then each can measure a deflection to the BP and can be plotted on the plotting board as in para 10-8a. Each piece can then be located with respect to the aiming circle that was used in laying.

b. If the aiming circles are intervisible, but one is not visible from the base piece:

(1) The circle visible from the base piece will be plotted as in para 10-8a.

(2) The circle not visible from the base piece will be plotted with respect to the first aiming circle in the same manner as would any piece (para 10-8b).

(3) Each piece is then plotted with respect to the aiming circle that was used in laying.

Section IV. HASTY TERRAIN GUN POSITION CORRECTIONS

10-14. General

Even with a well-trained FDC, the computation of TGPC is time-consuming. Often corrections are required for firing very shortly after occupation of position. If, as mentioned previously, the recon party determined displacement and computed TGPC, corrections will be available immediately. If the recon party has not been able to do this (e.g., a hasty occupation of position), a hasty (interim) TGPC solution must be determined and used until accurate TGPC are computed.

10-15. Hasty Solution

a. Hasty TGPC computations are designed to obtain a converged sheaf at the mid-range of the 4,000 meter TGPC sector. The converged sheaf is selected to speed up computations - once you have piece displacement, you know the required position correction in meters. Normally the piece displacements used in this solution are *ESTIMATED* values.

b. Corrections can be computed using a table similar to table 10-3. The data presented in this table are:

(1) Range in 1,000 meter increments.

(2) The charge most likely to be fired at each range. This value is dependent upon the situation; e.g., hilly terrain may require lower charges than normal to be fired.

(3) Deflection correction in mils to compensate for lateral piece displacement.

(4) Position correction in mils to compensate for the displacement in range.

(5) MV correction in mils to compensate for the difference in shooting strength (comparative VE).

(6) Refer to para 10-15e below for details on how to construct such a table.

c. The steps to be followed in using this

table to compute hasty TGPC for a particular piece along a given azimuth of fire are:

(1) Enter the table at the listed range nearest to that of the mid range of the 4,000 meter TGPC sector.

(2) Extract the deflection correction in mils for the lateral displacement nearest to the estimated displacement. If the piece is to the left (right) of BC, the correction is to the right (left). This is the correction to be placed on the gunner's aid of the weapon.

(3) Extract the position correction in mils for the range displacement nearest to the estimated displacement. If the piece is behind (in front of) BC the correction is plus (minus).

(4) Extract the MV correction in mils for the comp VE nearest to the comp VE of the piece in question.

(5) Add the corrections determined in (3) and (4) above. The result is the QE correction to be placed on the correction counter of the weapon.

d. *Example.*

(1) Given.

(a) The range band for the primary TGPC sector is 7,000 - 11,000 meters.

(b) The XO has estimated that piece 5 is 130M left/80M behind BC with respect to the azimuth of lay.

Note. The FDC can then place this estimated displacement on the plotting board and rapidly determine piece 5's "estimated" displacement for the left and right TGPC sectors.

(c) The comp VE for piece 5 is +2.3M/S.

(2) Solution.

(a) Enter with the mid-range of 9,000 meters. TGPC are based on charge 6.

Table 10-3. M109A1 155mm Hasty TGPC Solution.

Mid Range	Charge	Deflection Corrections (μ)										Position Correction (μ)					MV Correction (μ)									
		20	40	60	80	100	120	140	160	180	200	20	40	60	80	100	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	+4.5	+5.0		
																	-1.5	-2.0	-2.5	-3.0	-3.5	-4.0	-4.5	-5.0		
4,000	2	5	10	15	20	25	31	36	41	46	51	3	7	10	13	17	-7 +8	-10 +11	-12 +14	-15 +16	-17 +19	-19 +22	-22 +24	-24 +27		
5,000	4	4	8	12	16	20	24	29	33	37	41	2	3	5	6	8	-2 +3	-3 +4	-4 +5	-5 +6	-6 +7	-7 +8	-7 +10	-8 +11		
6,000	4	3	7	10	14	17	20	24	27	31	34	2	4	5	7	9	-3 +4	-5 +6	-6 +7	-7 +9	-8 +10	-9 +12	-10 +13	-12 +15		
7,000	5	3	6	9	12	15	17	20	23	26	29	2	3	5	6	8	-2 +2	-3 +3	-3 +3	-4 +4	-5 +5	-5 +5	-6 +6	-6 +7		
8,000	6	3	5	8	10	13	15	18	20	23	25	1	2	4	5	6	-2 +2	-2 +2	-3 +3	-3 +3	-4 +4	-5 +5	-5 +5	-6 +6		
9,000	6	2	5	7	9	11	14	16	18	20	23	1	3	4	5	7	-2 +2	-3 +3	-3 +3	-4 +4	-5 +5	-5 +5	-6 +6	-7 +7		
10,000	7	2	4	6	8	10	12	14	16	18	20	1	2	3	4	5	-2 +2	-2 +2	-3 +3	-3 +3	-4 +4	-4 +4	-5 +5	-6 +6		
11,000	7	2	4	6	7	9	11	13	15	17	19	1	2	4	5	6	-2 +2	-3 +3	-3 +3	-4 +4	-5 +5	-5 +5	-6 +6	-7 +6		
12,000	8	2	3	5	7	8	10	12	14	15	17	1	2	3	4	5	-1 +1	-2 +2	-2 +2	-3 +3	-3 +3	-4 +4	-4 +4	-5 +5		
13,000	8	2	3	5	6	8	9	11	13	14	16	1	2	3	4	5	-2 +2	-2 +2	-3 +3	-3 +3	-4 +4	-4 +4	-5 +5	-6 +6		
14,000	8	1	3	4	6	7	9	10	12	13	15	1	2	3	4	6	-2 +2	-3 +3	-3 +3	-4 +4	-4 +5	-5 +5	-6 +6	-6 +6		
15,000	8	1	3	4	5	7	8	10	11	12	14	1	2	4	5	6	-2 +2	-3 +3	-4 +4	-4 +5	-5 +5	-6 +6	-7 +7	-7 +8		
16,000	8	1	3	4	5	6	8	9	10	11	13	1	3	4	6	7	-3 +3	-4 +4	-4 +4	-5 +5	-6 +6	-7 +7	-8 +8	-9 +9		

(b) Extract a deflection correction based on a lateral displacement of 130M. Since 130 falls between 120 and 140M (nearest listed values), the correction for either may be used. In this case it is easily seen that the correction for 130M displacement is 15 mils, midway between the values of 14 mils (120M) and 16 mils (140M). The FDO selects 15 as the appropriate correction. Since piece 5 was left of BC, the correction is R15.

(c) Extract a position correction for the 80M displacement in range. The value is 5 and since piece 5 was behind BC, the correction is +5 mils.

(d) Extract an MV correction for a +2.3M/S comp VE. Enter at the nearest listed value of +2.5M/S. The correction is -3 mils.

(e) The quadrant elevation correction for piece 5 is--

$$+5 + (-3) = +2 \text{ mils}$$

e. Steps for constructing the hasty TGPC solution table (table 10-3) are:

(1) List the ranges to be fired with your weapon in 1000 meter increments.

(2) Select the charge most likely to be fired at each range.

(3) For each range, extract from the TFT the meter-per-mil and MV unit correction factors for the appropriate charge.

(4) Using the GST, compute (to the nearest mil) the deflection correction required for each 20 meters of lateral displacement (20-200M).

$$\frac{\text{Lateral displacement (20M)}}{\text{Rg in 1000}} = \text{Hasty TGPC DF Corr}$$

(5) Using the extracted meter-per-mil factor, compute the QE correction required for each 20 meters of front/rear displacement.

$$\frac{\text{Displacement}}{\text{Meter-per-mil factor}} = \text{Hasty TGPC Psn Correction}$$

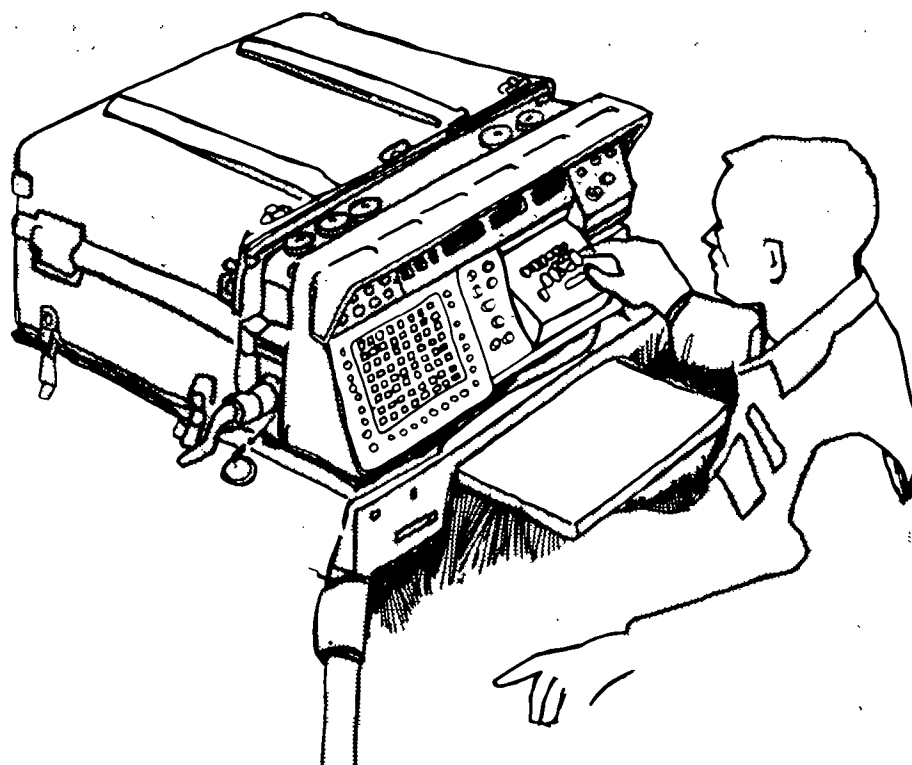
(6) Compute the MV correction using the formula: Hasty TGPC MV Corr =

$$\frac{\text{MV unit correction factor} \times \text{battery comp VE}}{\text{Meter-per-mil factor}}$$

Note. This only need be done for the actual battery comparative VE's; if no piece has a 5.0M/S comp VE don't compute a correction for this value.

CHAPTER 11

FIRE DIRECTION CENTER PROCEDURES FOR SPECIAL SITUATIONS



HOW THE FDC WILL COMPUTE FIRING DATA

CHAPTER 11

FIRE DIRECTION CENTER PROCEDURES FOR SPECIAL SITUATIONS

Section I. GUNNERY PROCEDURES FOR IMPROVED CONVENTIONAL MUNITIONS

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Section I. GUNNERY PROCEDURES FOR IMPROVED CONVENTIONAL MUNITIONS

11-1. General—Manual Procedures

The time consuming, complex manual procedures for determining ICM firing data have often caused field artillerymen to hesitate to use ICM. To simplify and speed up this process, the correction for low-level wind has been eliminated. Additionally, a simple modification to existing GFT's has been made to allow graphical determination of ICM firing data.

11-2. Application of ICM Scales to Existing Graphical Firing Tables

a. The procedures to modify existing GFT's are as stated in b through e below. All data are based on a 155mm M109A1 weapon system firing shell ICM, M449.

FUTURE GFT'S WILL INCORPORATE THE ICM SCALES DISCUSSED. THESE SCALES WILL BE FOR THE HIGH DENSITY ICM PROJECTILE OF THE GIVEN CALIBER. THIS PARAGRAPH IS TO BE USED IF SCALES ARE DESIRED FOR ANY OTHER ICM PROJECTILE FOR THAT CALIBER.

b. Using the appropriate ICM addendum (FT 155 ADD-I-1), charge (CHG 4GB) and type ICM projectile (M449), compute ICM QE's for all HE QE's listed in the addendum. The ICM QE is equal to the HE QE + the Ballistic Correction from Table 'A'.

Example

GIVEN: CHG 4GB

QE FOR HE M107	BALLISTIC CORRECTION	ICM QE
155	+97	252
160	+93	253
165	+90	255
170	+86	256
175	+83	258
180	+80	260
185	+78	263
190	+75	265

Note. This procedure will be continued throughout the limits of the GFT.

c. On the appropriate GFT (CHG 4), construct a line parallel to the existing scales. This line is to become the basis for the ICM quadrant and fuze setting scales. To prepare the ICM QE portion of the scale, construct a graduation on the ICM scale corresponding to each HE quadrant used in step b above. The first graduation is constructed corresponding to an HE quadrant of 155 mils. This graduation is labeled 252 which indicates an HE quadrant of 155 mils yields an ICM quadrant of 252 mils. Successive graduations are determined, plotted and labeled in the manner described above.

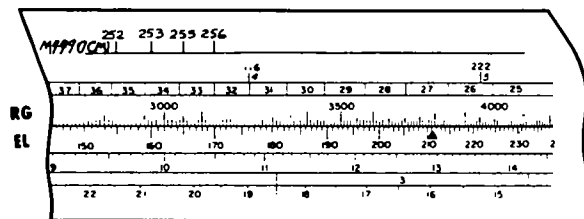


Figure 11-1. Application of ICM QE.

d. Having completed the ICM quadrant scale, construct the ICM fuze setting scale. The construction of this scale is similar to that for the quadrant scale discussed in b and c above. To compute an ICM fuze setting (fuze M565) enter table 'B' (CHG 4 GB) with the M564 fuze setting and apply the correction listed. The fuze setting for fuze M565 = fuze setting M564 + fuze setting correction. In the example below, the lowest listed fuze setting (M564) in table 'B', FT 155 ADD-I-1 (CHG 4 GB), is 9.6 and has a listed correction

M564	CORRECTION	M565 (ICM)
10.2	(-1.2)	9.0
11.1	(-1.1)	10.0
12.1	(-1.1)	11.0
13.1	(-1.1)	12.0
14.1	(-1.1)	13.0
.	.	.
.	.	.
.	.	.

of (-1.2); thus the fuze setting for fuze M565 is 8.4. By examining the table, similar computations can be made for each whole fuze setting on the ICM fuze scale. Plot and label each computed ICM fuze setting opposite its corresponding M564 fuze setting. Plot the 0.1 fuze setting increments by interpolation as shown in figure 11-2.

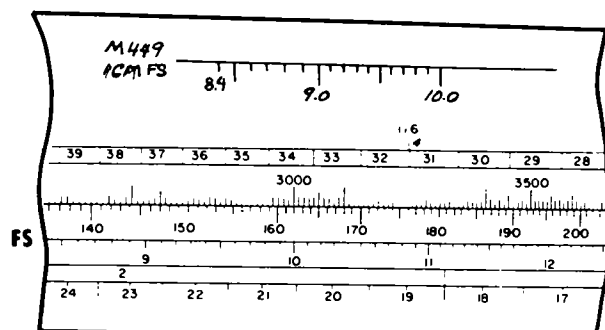


Figure 11-2. Application of ICM fuze setting.

e. Once the quadrant and fuze setting scales have been applied, ICM firing data are determined as follows:

(1) Using the announced chart range, deflection, and site, determine fuze setting, deflection, and quadrant elevation for the M107 projectile (M564 fuze).

(2) Determine the fuze setting M565 by placing the manufacturer's hairline (MHL) over the fuze setting for fuze M564. Read the M565 fuze setting underneath the MHL on the prepared M565 fuze setting scale.

(3) The piece deflection determined for shell ICM is the same as that determined for shell HE.

(4) Determine the ICM QE by placing the MHL over the HE QE on the elevation scale. Read the ICM QE underneath the MHL on the prepared ICM QE scale.

11-3. Example Problem (Manual Solution; Fire for Effect Mission)

a. *General.* The following problem (fig 11-3) illustrates the procedure for firing ICM. Although the M449 projectile and the ICM

scales prepared from FT 155-ADD-I-1 for the M109A1 howitzer are used in the example, these procedures are applicable for all weapons firing ICM.

b. *Known data for Battery "B", M109A1 Battery.*

GFT "B": CHARGE 4, LOT RS, RANGE 6080, ELEVATION 402, TIME 23.3

GFT DEFLECTION CORRECTION: R2

LOT S IS GREEN BAG

c. *Situation.* The following call for fire has been received in the Battery "B" FDC.

P51 THIS IS P87, FIRE FOR EFFECT, SHIFT REGISTRATION POINT 1, OVER.

DIRECTION 560, RIGHT 450, ADD 400, OVER.

PLATOON ASSEMBLY AREA, ICM OVER.

d. *Situation continued.*

(1) The FDO has issued the following fire order:

FIRE FOR EFFECT, SHELL ICM, LOT MS, 3 ROUNDS.

(2) The HCO announces chart data as

"B" RANGE 4960, DEFLECTION 3094.

e. *Determination of ICM (M449) firing data - see figure 11-3.*

(1) Once initial chart data have been announced, the computer determines HE firing data. He then converts that data to ICM firing data as previously discussed.

(2) Using the announced chart data and his GFT, the computer determines the following M107 data:

FUZE SETTING, M564	ELEVATION	DRIFT CORRECTION
18.0	304	L6

FM 6-40-5

(3) Placing the manufacturer's hairline over 18.0 on the M564 fuze setting scale, the computer reads a fuze setting, M565, of 16.9.

(4) The computer determines and announces piece deflection as follows:

GFT DEFLECTION CORRECTION	R2
+ DRIFT CORRECTION	+(L6)
DEFLECTION CORRECTION	L4
CHART DEFLECTION	3094
+ DEFLECTION CORRECTION	+(L4)
PIECE DEFLECTION	3098

Note. The piece deflection determined for ICM is the same as that determined for HE.

(5) The computer determines and announces ICM quadrant elevation as follows:

(a) Determine HE quadrant elevation.

HE ELEVATION	304
+ SITE	+(+)3
HE QUADRANT ELEVATION	307

(b) Placing the manufacturer's hairline over HE quadrant 307 on the elevation scale, the computer reads an ICM QE of 347.

11-4. General—FADAC Procedures

a. After mission data have been entered into FADAC, compute firing data for ICM munitions by designating the appropriate projectile and fuze. You do this by entering flags in matrix locations B-5 (PROJ TYPE) and B-6 (FUZE TYPE). The following flags are used:

	FLAG
(1) Projectile	
(a) 105mm	
Shell M444	6
(b) 155mm	
Shell M449	6
Shell M449A1	7
Shell M449E1	8

(c) 8-inch

Shell M404 6

(2) Fuze (all calibers)

Time fuze M548 or
M565 7

b. The height of burst for the particular caliber projectile is automatically determined. The corrections for the effects of low level winds on the submunitions after burst are automatically applied.

c. In an adjustment of the height of burst for the ICM, entering an UP/DOWN correction in matrix location A-8 (UP/DOWN) will cause the FADAC to apply the correction to the target altitude.

11-5. Registration Corrections

a. FADAC will only store one set of registration corrections per charge. Normally the corrections are stored for application to all shells ballistically similar to the HE shell (i.e., WP, gas, and smoke). The ICM projectiles are not ballistically similar to the HE projectile. WHEN REGISTRATION CORRECTIONS HAVE BEEN DETERMINED AND ARE TO BE USED WHEN COMPUTING FIRING DATA FOR THE ICM PROJECTILE, THE HE CORRECTIONS MUST BE ENTERED INTO FADAC FOR THE ICM AS ILLUSTRATED IN THE EXAMPLE PROBLEM IN PARAGRAPH 11-6 BELOW.

b. When the ICM mission has ended, corrections are reentered for the HE family of projectiles.

11-6. Example Problem (FADAC Solution; Fire for Effect Mission)

a. *Known data for battery B, 155mm M109A1 howitzer.*

(1) Easting	: 60858
(2) Northing	: 32640
(3) Altitude	: 352
(4) Azimuth of lay	: 6350
(5) Referred deflection	: 3200
(6) Grid declination	: 6 East

- (7) Latitude : 35°N
 (8) Projectile weight : Standard
 (9) Powder temperature : +57
 (10) Muzzle velocity : Unknown
 (use standard)

(11) Meteorological data:

METCM1	345982
261650	036987
00 010011	2693 0987
01 048019	2679 0974
02 032014	2673 0954
03 056037	2617 0898
04 014015	2672 0838
05 540014	2718 0793

(12) ICM ammunition on hand:

100 rounds M449E1 (flag 8)

b. Situation. Battery B has registered with lot XY charge 4GB. The residual corrections were determined to be:

Deflection	L18
Time	-0.3
Range K	+22

c. Situation continued. A call for fire has been received from the FSO with the supported brigade to fire for effect on an assembly area. ICM has been requested. The following target data are known.

Target grid: 61550 36700

Target altitude: 389

d. Procedures.

(1) Enter the known data.

(2) Enter the mission data and registration corrections. *COMPUTE* firing data as follows:

Step	<u>Activate button or matrix location</u>	<u>Keyboard</u>	
1	Battery B selector button	none	
2	A-1 TGT EAST	SM; 61550;	ENTER
3	A-2 TGT NORTH	SM; 36700;	ENTER
4	A-3 TGT ALT	SM; 389;	ENTER
5	B-1 CHG	SM; 4;	ENTER
*6	B-5 PROJ TYPE	SM; 8;	ENTER
7	B-6 FUZE TYPE	SM; 7;	ENTER
*8	F-6 DF CORR	SM; 4; ENTER; LEFT 18;	ENTER
*9	F-7 TIME CORR	SM; 4; ENTER; -0.3;	ENTER
*10	F-8 RANGE K	SM; 4; ENTER; +22; ENTER	
11	COMPUTE		

e. Solution.

<u>Battery</u>	<u>Charge</u>	<u>Deflection</u>	<u>Time (FS)</u>	<u>Quadrant elevation</u>
B	4	2996	13.9	319
12	E-1 EM		SM; 0	
*13	F-6 DF CORR		SM; 4; ENTER; LEFT 18; ENTER	
*14	F-7 TIME CORR		SM; 4; ENTER; -0.3; ENTER	

*15

F-8 RANGE K

SM; 4; ENTER; +22; ENTER

**Note.* When registration corrections (residuals) for shell HE are used with shell ICM, they must be entered *after* the appropriate projectile flag has been entered in location B-5 (PROJ TYPE). Upon completion of the ICM mission, the residuals must be reentered for the HE family of projectiles. Failure to reenter the residuals following an ICM mission will result in the failure of FADAC to apply the corrections to firing data computed for the HE family of shells. The recall display for functions F-6 (DF CORR), F-7 (TIME CORR), and F-8 (RANGE K) *does not* indicate the shell type for which corrections (residuals) are stored in memory; therefore, the operator must insure the corrections are correctly stored for the projectile type by using the illustrated procedures.

Section II. GUNNERY PROCEDURES FOR SMOKE PROJECTILES

11-7. Immediate Smoke

a. Considerations. Immediate smoke is fired with a high degree of urgency and demands immediate response in the FDC. Normally it is fired as a followup to an immediate suppression mission. It may, however, be fired as a separate mission.

agencies (FO and FSO) of the amount of smoke ammunition available. The FO and FSO must always know the DS battalion's smoke capability so that they can provide adequate planning information for the maneuver elements.

b. Computations. The procedures for deter-

DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Immediate Smoke * (Point/Suppression)	Point or small area 150M or less	1 Plt (2 Guns)	1st Rd's WP-HC 2d Rd's HC	Parallel or terrain gun position corrections	½ - 5 min	By SOP and/or approval of maneuver company commander

* The immediate smoke technique can be used in an immediate suppression mission on a target of opportunity; by unit SOP, a mix of WP and HC will normally follow the initial suppression rounds when immediate smoke is requested.

b. Computations. Because of the urgency of the mission, ignore projectile weight differences. Fire WP with fuze quick. Fire both WP and HC rounds using HE data except that for HC:

(1) **DO NOT APPLY 20/R.**

(2) **SUBTRACT 2 SECONDS** from the M564 fuze setting to achieve the proper height of burst with the M501 fuze.

11-8. Quick Smoke

a. Considerations. To insure the ability to fire quick smoke in support of maneuver elements, periodically inform the requesting

mining firing data for quick smoke are the same as those for a normal HE adjust fire mission. If the forward observer requires smoke for an extended period of time (more than 2 minutes for WP and 5 minutes for HC), however, you will need to make additional computations. These additional computations are the time length of replenishment to provide the requested duration of the quick smoke, the rate of fire, and the total number of rounds per gun. **WHEN THE RATE OF FIRE MUST BE COMPUTED**, the FO must send to the FDC the wind speed, the smoke condition, and the length of time the smoke is required.

DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Quick Smoke (Small Area/Suppression)	Small area 150 to 600M	1-2-3 Plt	HC or WP	Parallel or terrain gun position corrections	4-15 min	Approval of maneuver battalion commander

Example

Known data

--155mm howitzer battery

--base piece is number 4

THIS IS H24, ADJUST FIRE, QUICK
SMOKE, 2 PLATOONS, OVER.

GRID 593276, OVER.

SCREEN TREE LINE, FAVORABLE,
5 KNOTS, DURATION 9 MINUTES,
HC IN EFFECT, OVER.

INITIAL CALL FOR FIRE

(1) Determine the *TOTAL TIME* during
which smoke is *TO BE REPLENISHED*.

Length of time smoke
required. 9 minutes

Time to build to effective
level (table 11-1) + 1 minute

Duration of smoke = 10 minutes

Average burning time
(table 11-1) - 4 minutes

Total time during which
smoke is to be
replenished = 6 minutes

Table 11-1. Smoke round effectiveness.

	105mm		155mm	
	HC	WP	HC	WP
Time for Buildup	1 min	½ min	1 min	½ min
Average Burn Time	3 min	1 min	4 min	1 min

Table 11-2. Rate of fire.

SMOKE CONDITIONS	WIND SPEED IN KNOTS	ROUNDS PER MINUTE			
		105mm		155mm	
		HC	WP	HC	WP
Ideal	5	1	1½	½	½
Favorable	5	1	2	½	1
	10	2	4	1	2
	15	2½	6	1½	3
Marginal	5	3	*	1½	*

* Under these conditions the number of rounds
exceeds the rate of fire for the weapon.

(2) Determine the *RATE OF FIRE*.

(a) Enter table 11-2 with the Smoke
Condition of favorable and wind speed of 5
knots.

(b) Extract the rate of fire of 1/2 round
per minute per gun (1 round every 2 minutes)
under the column for 155mm HC.

(3) Calculate the *TOTAL NUMBER OF
ROUNDS PER GUN*.

(a) Determine the number of sustain-
ing rounds required per gun by multiplying
the rate of fire by the duration of replenish-
ment ($1/2 \times 6 = 3$ rounds).

(b) Add the initial fire-for-effect HC
round to the sustaining rounds ($1 + 3 = 4$
rounds).

Therefore, each piece will fire one round of
HC smoke initially in fire for effect and one
round every 2 minutes for the next 6 minutes
to provide effective smoke for 10 minutes.

c. Execution.

(1) Prior to issuing the fire order and
announcing fire commands to the guns,
choose the center-most gun of the fire-
for-effect platoons as the adjusting piece.

FDO's Fire Order

RIGHT AND CENTER, NUMBER
3, 1 ROUND, CHARGE 4, HC IN
EFFECT.

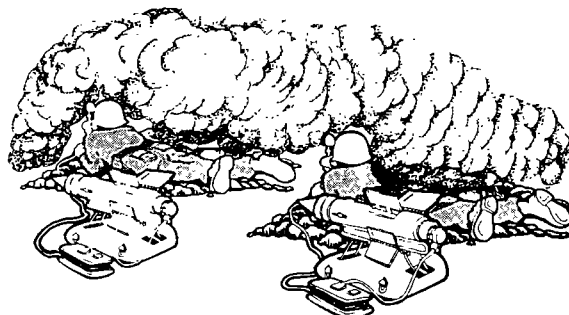
Computer's Fire Commands

FIRE MISSION, RIGHT AND
CENTER ADJUST, NUMBER 3, 1
ROUND, CHARGE 4, DEFLECTION
3190, QUADRANT 274, HC IN
EFFECT.

(2) Since the computations for the num-
ber of rounds per piece and the rate of fire
are accomplished while the adjustment is
being conducted, the fire-for-effect fire com-
mands will be announced after the observer
has completed his adjustment (the FDC will
control the time of firing of the HC rounds).

Computer's Fire Commands

RIGHT AND CENTER 4 ROUNDS, BY ROUND AT MY COMMAND, SHELL HC, FUZE TIME, 18.6, DEFLECTION 3195, QUADRANT 288.



Section III. DEDICATED BATTERY TECHNIQUES

11-9. Communications

Timely transmission of fire missions is a key to immediate suppressive fires, especially when the enemy can jam any previously exposed net. The DS battalion requires one CF alternate and one retransmission frequency in addition to its CF net and three F nets to assure timely transmission of calls for fire. Assurance is further increased by:

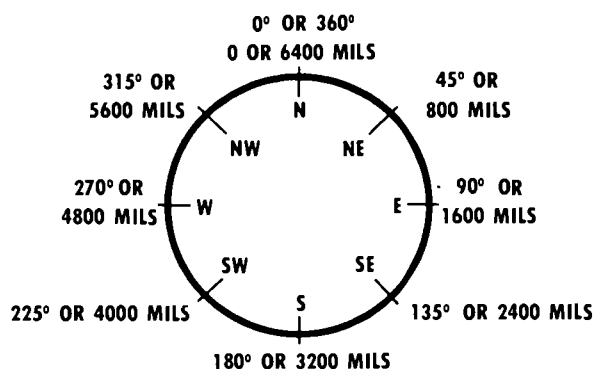
- a. Restricting FM traffic to tactical/time-sensitive messages.
- b. Not using F nets until the tactical situation, or traffic, demands initial exposure by the FO.
- c. Employing the DS battalion retransmission station in the best position to provide emergency transmission service to all subordinate stations.
- d. Having the battalion FSO constantly capable of retransmitting messages between the FO and the FDC.
- e. Dedicating an entire F net for exclusive use by a dedicated battery.
- f. Maintaining communications when one dedicated battery relieves another (relieving battery, using its own call sign, enters the

dedicated F net and responds to calls for fire sent to either battery).

11-10. Talk Untrained Observer Through Mission

Calls for fire from maneuver personnel acting as observers will require more of the FDO's attention to insure responsive fire support. In this situation FDC personnel must:

- a. **TAKE THE INITIATIVE** if the observer hesitates. Ask:
 - (1) Where is the target?
 - (2) How close is the target (direction and distance)?
 - (3) What is the target?
- b. **USE A SIMPLE CONVERSION DIAGRAM** to convert degrees and points of the compass to mils. **MAKE SURE** you know which unit he is using to report directions.
- c. **EXPLAIN "SPLASH"**. Tell the observer when to look for rounds.
- d. **ASSIST IN MAKING CORRECTIONS**. Have the observer tell where the rounds landed in relation to the target or ask him



which way the rounds need to be moved and how far. The FDC must be prepared for an unusual shift or combination of shifts that may indicate the observer is misoriented. When in doubt, and the target is close to friendly forces, . . . *CREEP*.

e. *USE SOUND JUDGMENT* in deciding whether or not to require the untrained observer to authenticate his mission.

11-11. Target/Checkpoint Numbering

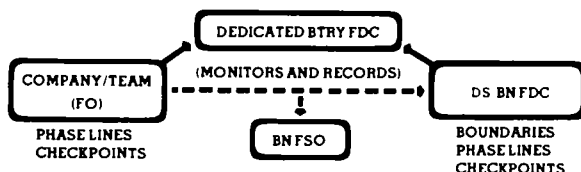
Targets/checkpoints, probably will not be used by FO's and maneuver personnel unless they can be easily remembered. Target/checkpoint numbers are dangerous to use in an FDC if one designation refers to more than one point on the ground. Therefore, a *SIMPLE* and *STANDARDIZED* target/checkpoint numbering system is required. Such a system should:

a. Designate targets with a two digit number (e.g., 11).

b. Designate checkpoints with a circled one or two digit number (e.g., ⑦).

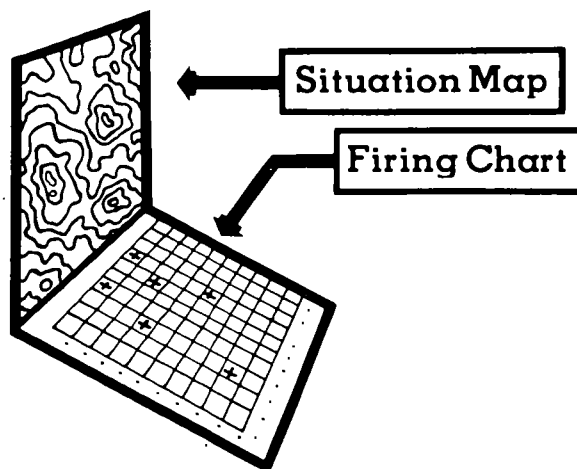
11-12. Maneuver Control Measures

The company/team scheme of maneuver and control measures must be available to, and understood by, the FO, the battalion FSO and the FDC's of the dedicated battery and DS battalion.



a. FSO's at all levels must insure that control measures get to the DS battalion FDC, which will pass them to the firing batteries. The FO must insure that the company/team commander's control measures are at the dedicated battery FDC. The flow of information to the dedicated battery FDC is shown to the left below.

b. The dedicated battery FDO must insure that these control measures are *IMMEDIATELY AVAILABLE* within his FDC. The maneuver control measures can be plotted on a situation map (1:25,000 ortho-picto if available) which will be in front of, or adjacent to, the chart operator. Checkpoints will be plotted in blue on the firing chart itself.



11-13. Monitor and Record Advance of Maneuver Force

To reduce response time, the dedicated battery FDC must anticipate the needs of the maneuver force. To do this FDC personnel must plot the company's/team's checkpoints, know each element's call sign, and follow the tactical situation by monitoring their command net. When the leading maneuver element passes a checkpoint, the element's call sign and crossing time will be recorded in the lower right hand corner of the corresponding tickmark on the chart.

11-14. Firing Data

a. The dedicated battery FDC will plot the battery location, targets, checkpoints, and fire support coordinating measures in zone.

b. The range-deflection protractor will be marked with charge lines to indicate the charge to be fired at targets located beyond each line. (The ballistic scale of the GFT fan normally provides the required charge lines). To establish charge lines on the RDP:

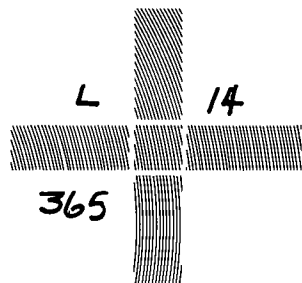
- (1) Plot the requested targets and checkpoints.
- (2) Determine minimum and maximum ranges that the dedicated battery is expected to fire.
- (3) Select the *HIGHEST* charge consistent with the minimum QE and intermediate crest restrictions (reduces reaction time), and
- (4) Place and label the charge lines on the arm of the RDP.

11-15. Target Engagement

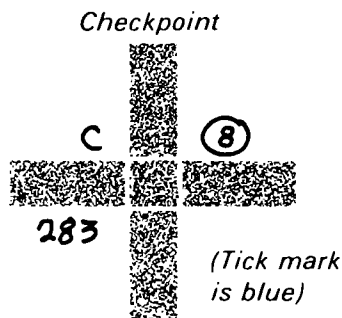
a. The key to suppressing an enemy direct fire weapon is to *IMMEDIATELY* put some fire close enough to kill, injure, or distract the gunner. To do this, a dedicated battery must be able to fire *IMMEDIATE SUPPRESSION* missions on both planned targets and targets of opportunity. Ideally, every suppression mission would be fired in less than 20 seconds on a planned priority target by having a platoon laid on the target with current firing data placed on the guns and a prepared HE/VT round on each loading tray.

b. The command to fire on a *PLANNED TARGET* contains the elements to fire and *SUPPRESS* (target number). For example to suppress target 46 the FDC would command

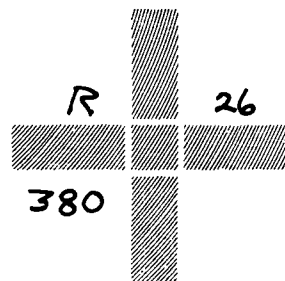
LEFT, SUPPRESS 46.



Planned Target



(Tick mark is blue)



Planned Target

The chiefs of section for the left platoon howitzers check to see if they are laid on target 46. If so, they simply load and fire. If not laid on target 46, they refer to their *GUNNER'S REFERENCE CARD*, apply the correct data to the howitzer, load, and fire.

c. *REMEMBER "IMMEDIATE SUPPRESSION"* means "*WE NEEDED FIRE 10 SECONDS AGO*". The dedicated battery supplies these fires by assigning planned targets to each platoon and, as the maneuver unit advances, redesignating priorities at the company's/team's direction. Lacking guidance, the BC/FDO must anticipate their needs. When immediate suppression is requested, the BC/FDO will direct the appropriate platoon to fire one round for danger-close missions or three rounds for more distant targets. The latter gives the FO time to send a correction or better target description *WHILE THE TARGET IS BEING SUPPRESSED*. It also gives the BC/FDO time to determine if additional fire is required and if augmentation from other platoons or units is needed. If other platoons are used, they must be able to shift back to their assigned priority targets upon notification.

d. The dedicated battery must be able to respond simultaneously to two requests for immediate suppression. A priority mission should be fired by the platoon to which it is assigned. The FDC can keep track of this by writing "L" (left platoon), "C" (center), or "R" (right) in the top left quadrant of a priority target tick mark or by keeping a list of which gun has data for other planned targets. Other targets should be engaged by the most responsive platoon, considering the friendly situation and current priority target assignments.

11-16. Additional Duties of the Battery FDO and Battalion S3

a. The FDO of the dedicated battery must:

(1) Insure that all members of the FDC fully understand the procedures for using a fire plan sent by the gridded thrust line method.

(2) Insure that firing data are developed for both targets and checkpoints. This requires directing that a specified fuze setting for each target, or a general one for a number of targets, be used. The latter facilitates massing fires.

(3) Decide which platoon will lay on which targets based on the priorities established by the company/team commander and FO.

(4) Monitor the advance of maneuver elements and plot it on the chart.

(5) Direct the platoons to re-lay on new data and prepare ammunition as priorities change.

(6) Immediately forward to the battalion FDC, any information developed at the battery.

b. The DS battalion S3:

(1) Must position the dedicated battery in the best possible location.

(2) Must give first priority for position

area survey to the dedicated battery.

(3) Should coordinate with the battalion XO and S4 to insure that the dedicated battery has priority on any maintenance assistance required.

(4) Must coordinate with the battalion S4 to insure that the dedicated battery has the appropriate ammunition in its area.

(5) Should insure the dedicated battery has current meteorological data.

(6) Should provide the dedicated battery with engineer support, if available, for hardening its position.

(7) Must anticipate the possible need to switch the dedication from one battery to another as a result of hostile action, range limitations, masking, or changes in the scheme of maneuver. Plans must be developed to insure that all required information is received by the relieving battery.

(8) Will accept reports of hostile indirect fires and initiate counterfire procedures, as required. Dedicated batteries must not be otherwise involved in counterfire operation.

(9) Must insure that the division artillery FDC knows the status of dedication so that it will not plan to use dedicated batteries in massed fires.

(10) Must be prepared to augment the fires of the dedicated battery.

Section IV. 155MM HOWITZER NUCLEAR DELIVERY

11-17. Computations

a. Chapter 24, FM 6-40, presents a detailed discussion of the manual fire direction techniques for delivery of the 155mm nuclear projectile. In the met correction technique, the position VE and position fuze correction are assumed to be zero. When charge 1 is to be fired from the M109A1 howitzer, however, a position VE of +2.4M/S is used. This is necessary to correct for the difference between M109 and M109A1 charge 1 standard MV's.

Note. In the near future, this technique will include a tube wear correction to the muzzle velocity.

b. When using the met correction technique, complementary range is determined by entering table B in FT 155-AJ-2 with vertical interval (VI) and range to the nearest 100 meters, and extracting the value of comp range.

Note. It is recognized that certain inaccuracies exist using this procedure. However, it is believed the simplicity and responsiveness of the system offsets the accuracy loss.

11-18. Example

The determination of firing data for a 155mm howitzer nuclear mission using the met correction technique may be simplified

by transferring data from the met data correction sheet to the 155mm nuclear computation form as shown in figure 11-4.

155mm NUCLEAR COMPUTATION-MET CORRECTION TECHNIQUE			
Btry	<i>B</i>	Piece Number	<i>6</i>
DTG	<i>2407120CT</i>		
Tgt			
1	Entry Rg (from met form)	<i>5834</i> (1M)	FIRING DATA
2	Total Rg Corr (from met form)	<i>-166</i> (1M)	
3	Corrected Rg (<u>1</u> plus <u>2</u>) [<i>5668</i> (1M)]	<i>≈5670</i> (10M)	
4	TS ~3 (TFT, Tbl F, Col 4)	<i>22.4</i> (0.1)	
5	Total Fz Corr to Tgt (from met form)	<i>+0.3</i> (0.1)	
6	Intermediate TS (<u>4</u> plus <u>5</u>)	<i>22.7</i> (0.1)	
7	Temp Corr (TFT, Tbl K)	<i>0.0</i> (0.1)	
8	Corrected TS (<u>6</u> plus <u>7</u>)	<i>22.7</i> (0.1)	
9	Back Off Time (VT ONLY) (TFT, Tbl L)	<i>---</i> (0.1)	
10	TS to Fire (<u>8</u> minus <u>9</u>)		<i>22.7</i> (0.1)
11	Chart Df	<i>3181</i> (1M)	
12	Total Df Corr (from met form)	<i>L13</i> (1M)	
13	Df to Fire (<u>11</u> plus <u>12</u>)		<i>3194</i> (1M)
14	HOB Above Gun (from met form)	<i>+67</i> (1M)	
15	Chart Rg	<i>5810</i> (10M)	
16	Angle of Site (<u>14</u> ÷ <u>15</u> C&D Scales, GST)	<i>+12</i> (1M)	
17	EI ~3 (TFT, Tbl F, Col 2)	<i>383</i> (1M)	
18	QE to Fire (<u>16</u> plus <u>17</u>)		<i>395</i> (1M)

FORM
DA 1 MAY 76 4505

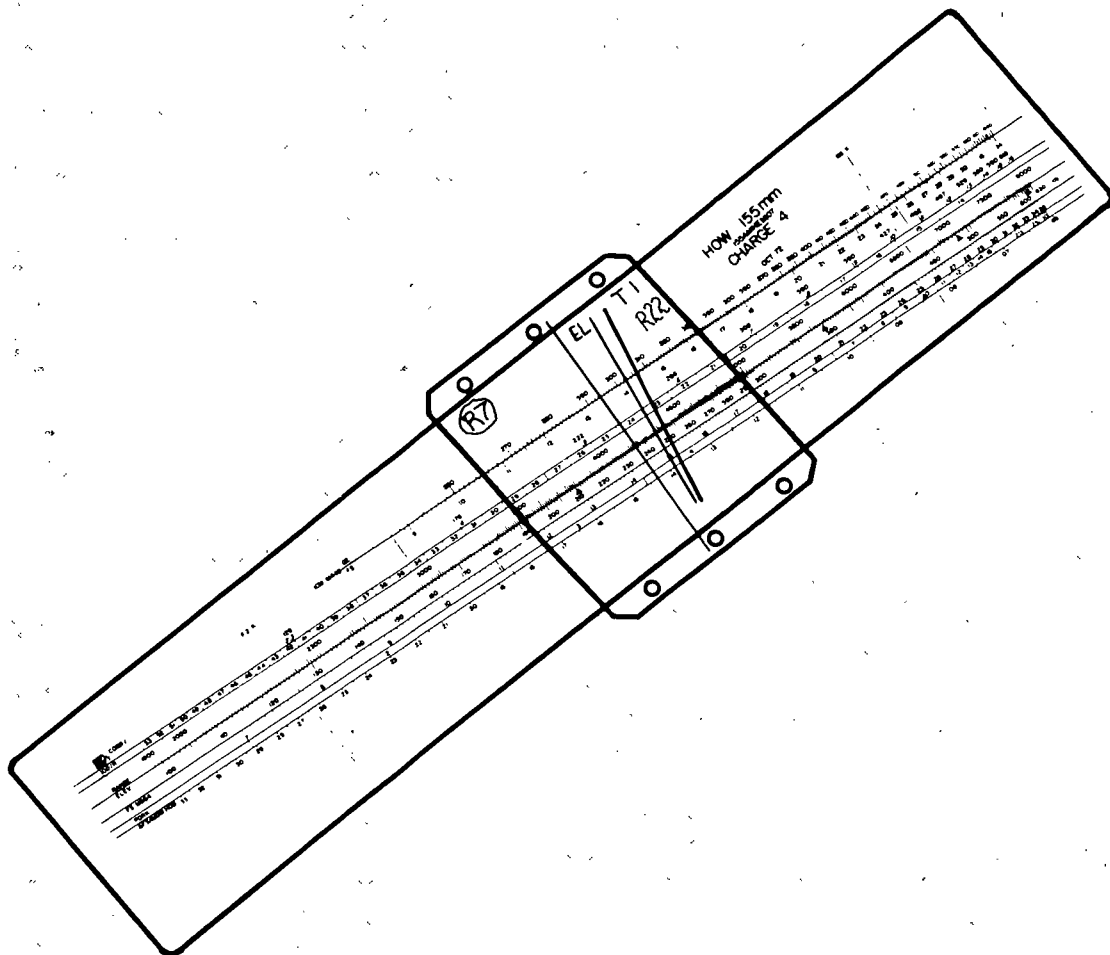
For use of this form, see FM 6-40-5; the proponent agency is US Army
Training and Doctrine Command.

Figure 11-4. 155mm nuclear computation - met correction technique.

CHAPTER 12

FM 6-40-5

REGISTRATIONS AND SURVIVABILITY



CHAPTER 12

REGISTRATIONS AND SURVIVABILITY

Section I. LIMIT REGISTRATIONS

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Section I. LIMIT REGISTRATIONS

12-1. General

a. The purpose of a registration is to determine firing data corrections which will compensate for the cumulative effect of non-standard conditions.

b. A mission conducted solely for the purpose of registering does not inflict damage on the enemy. It does, however, expose the firing unit to detection by enemy target acquisition assets. Consequently, registration missions should be held to an absolute minimum.

12-2. Limit Registrations

a. Registration is not necessary if you have confidence in:

(1) Weapon location and directional control. Field artillery survey provides the most accurate location and directional control for the firing battery. The firing unit can also be located with confidence by map-spotting a location near a prominent feature or by three-point resection performed with an aiming circle and a good map. Directional control can be extended by directional traverse, simultaneous observation, or acquired with an accurately declinated aiming circle or compass. Detailed procedures for hasty survey are given in FM 6-2 and FM 6-50.

(2) Met. If current meteorological data (less than 2 hours old, met station within 32 kilometers) are not available, the following priorities for use of other met apply:

(a) Current met message from nearest met station (upwind best) over 32 kilometers away.

(b) Met message greater than 2 hours old from met station within 32 kilometers. A 4 or 6 hour old message may be used except during the day/night transition or following obvious weather changes. The older the met, the less likely that it will provide improvement to field artillery fire.

(3) Muzzle velocity. The major causes of change in muzzle velocity are erosion (tube wear) and changing propellant lots. Erosion is gradual and will depend on the amount of firing. Wear tables in each tabular firing table may be used to help estimate when it will be necessary to perform calibration or registration.

b. If you don't have confidence in one or more of the three elements needed for MET + VE firing techniques, you should register. When registration isn't possible, use adjust fire techniques for observed fires and the best available MET + VE solution for unobserved fires (fig 12-1).

DO YOU HAVE CONFIDENCE IN:

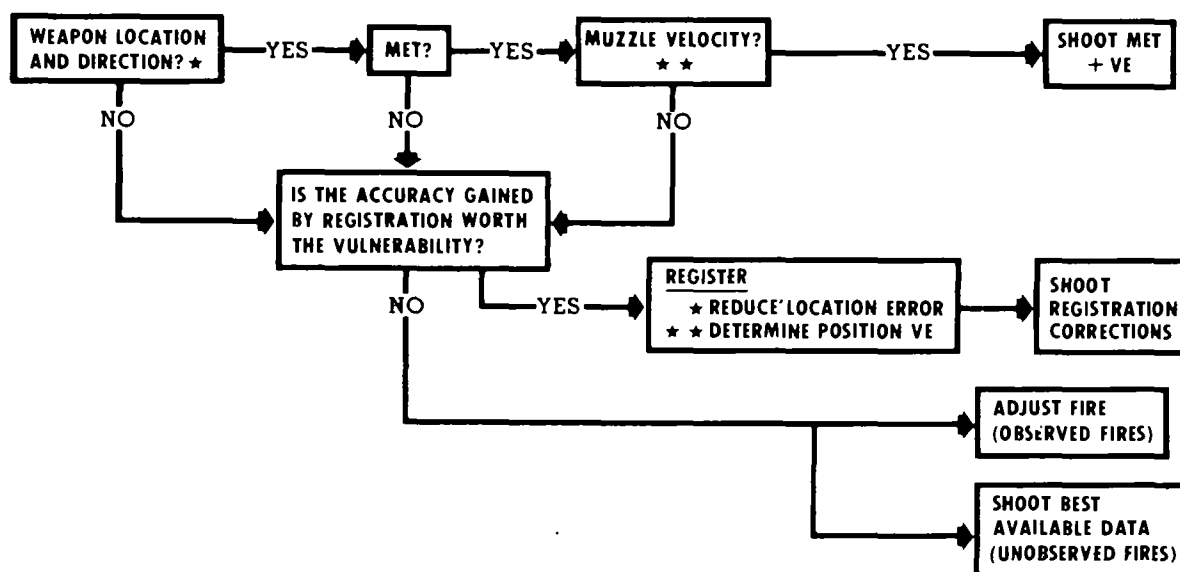


Figure 12-1. When to register.

Section II. REGISTRATION OPTIONS

12-3. General

A number of options are available to obtain corrections needed for massing and predicted fire. The option selected will depend on vulnerability considerations and the degree of accuracy required.

12-4. Registration Options

a. Offset registration. Register from a supplementary position. The enemy may acquire the gun location but it will not be there after the registration is over. You may disguise the registration by simultaneously firing from other locations; this will decrease the vulnerability to enemy target acquisition.

b. Abbreviated HB/MPI registration. An abbreviated high-burst or mean-point-of-impact registration can provide the battery with firing corrections. The registration may be fired with as few as 1, 2, or 3 rounds.

ASSURANCE OF REGISTRATION VALIDITY						
NO. OF ROUNDS	1	2	3	4	5	6
WITHIN 1 PE	50%	66%	76%	82%	87%	90%
WITHIN 2 PE'S	82%	94%	98%	99%	99%	99%

c. Abbreviated precision registration. A precision registration may be terminated as soon as the observer feels that his correction would put the next round fired on the registration point. Registration corrections may be determined from an area fire mission if the target is ACCURATELY located.

d. Registration to the rear. Registering in the opposite direction from the enemy will (by increasing the range from the enemy radar to the trajectory) greatly decrease the probability of detection and increase the enemy's location error (see para 12-15).

e. Complete registration. Complete registrations provide the highest degree of accuracy for registration corrections but also provide the enemy with the ideal conditions for target acquisition. (See Section III for detailed precision registration procedures.)

ABBREVIATED REGISTRATIONS SHOULD BE APPROACHED WITH CAUTION. INSURE THAT THE ROUNDS USED TO DETERMINE REGISTRATION CORRECTIONS WERE NOT FIRED FROM A "COLD" TUBE.

Section III. PRECISION REGISTRATON

12-5. General

a. Precision registration is a technique for determining, by adjustment, the firing data that will cause the mean point of impact of a group of rounds to occur at a point of known location, called a registration point.

b. The current precision registration technique is often referred to as the "ABCA registration".

c. Fire order. The FDO indicates whether an impact or an impact and time registration will be fired and announces any variations from the standard fire order.

d. Two lot registration. If a two-lot registration is to be conducted, the FO is alerted when he is told to register (see para 6-12b).

T16 THIS IS T42, REGISTER ON REG PT 1, QUICK AND TI, 2 LOTS, OVER.

e. Range probable error. The range probable error is determined for all impact registrations. When the range probable error is 25 meters or greater, it is announced to the observer.

12-6. Impact Registration

a. The chart operator plots all corrections by the observer on the firing chart and determines chart data from which firing data are determined.

b. The final location of the plotting pin on the firing chart is the mean location of the spottings in fire for effect. The deflection

measured to this location is the adjusted deflection. If a piece other than base piece is used, this is the correct rather than the adjusted deflection. The range measured to this location is used in determining the adjusted elevation.

12-7. Time Registration

a. If a time registration is required after the impact registration has been completed, the observer determines and announces refinement data and commands for the time registration.

RIGHT 10, ADD 10, RECORD AS REGISTRATION POINT 1, TIME REPEAT, OVER.

FIRE ORDER STANDARDS	
ELEMENT	CURRENT STANDARD
UNIT TO FIRE	BTRY
ADJUSTING ELEMENT/ METHOD OF FIRE OF ADJUSTING ELEMENT	# 3 ①
BASIS FOR CORRECTION	FASTEST METHOD
DISTRIBUTION	PARALLEL SHEAF
PROJECTILE	HE
AMMUNITION LOT & CHARGE	YZ/4
FUZE	Q
NUMBER OF ROUNDS	①
RANGE SPREAD, LATERAL SPREAD, SWEEP FIRE	CENTER RANGE AND DEFLECTION
TIME OF OPENING FIRE	WHEN READY

b. The FDC plots the refinement data and computes firing data. The initial fuze setting is that fuze setting corresponding to the adjusted elevation plus any known fuze correction. The ground site is modified by 20/R.

c. The observer adjusts the mean height of burst of four rounds fired at the same data to 20 meters above the registration point.

12-8. Example Precision Registration (Impact & Time)

An example registration (manual) is provided in figures 12-2 through 12-4.

FIRE COMMAND STANDARDS	
ELEMENT	STANDARD ELEMENT BY CURRENT SOP
WARNING ORDER	
PIECES TO FOLLOW/ PIECES TO FIRE/ METHOD OF FIRE	# 3 ①
SPECIAL INSTRUCTIONS	
PROJECTILE	HE
AMMUNITION LOT	YZ
CHARGE	
FUZE/FUZE SETTING	Q
DIRECTION	
QUADRANT ELEVATION	
METHOD OF FIRE	

Figure 12-2. Fire order and fire command standards used with examples in figures 12-3 and 12-4.

RECORD OF FIRE																
Observer <u>H8T34</u>		CALL FOR FIRE		AF/FFE/IS/S <u>REG</u> **		Tgt				Δ FS <u>0.12</u>						
Grid:										100/R <u>20</u>						
Polar: Dir		Dis		U/D		VA ±				/R						
Shift <u>DIR 430</u>		Dir		L/R		+/-		U/D		20/R <u>4</u>						
FIRE ORDER <u>PRECISION REGISTRATION, Q & T1</u>										Df Corr <u>L9</u>		Si <u>+5</u>				
INITIAL FIRE COMMANDS		FM		MF <u>BP ADJUST</u>		Rg <u>5060</u>		Chf Df <u>3304</u>		EI <u>299</u>						
Sp Instr <u>MISSION BEGAN WITH MTO</u>		Sh		Lot		Chg <u>4</u>		Fz		Ti		Df <u>3313</u>		QE <u>304</u>		
MTO <u>REGISTER ON REG PT 1, Q & T1</u>		4 (880) 600		PER (225)		TF		Q & T1		in Eff		Ammo Exp <u>(1)</u>				
Tgt	Location	Priority	Firing Unit	SUBSEQUENT FIRE COMMANDS										AMMO		
Dir, MF	Dev	Rg	HOB Corr	MF, Sh	FS	Ti	Chart Df	Df Corr	Df Fired	Chart Rg	HOB Corr	Si	EI	QE	Exp	Type
		-100					3316	L9	3325	4980		+5	293	298	(2)	
		+50					3310	L9	3319	5020		+5	296	301	(3)	
(2)		-25		(2)			3312	L9	3321	5000		+5	295	300	(5)	
(1)		+25		(1)			3310	L9	3319	5020		+5	296	301	(6)	Q
	R10	-10 REC					3311	L9	(3320)	5010			(296)			
AS REG PT 1, T1	RPT			FZ T1		17.8			3320		+4	+9	296	305	(1)	
(3)	RPT			(3)		(17.8)			(3320)					305	(4)	T1
REC AS T1 REG PT 1, EM						-0.1 (17.7)										

Note 1. The mission began with the message to observer.

Note 2. A time lag occurred in this mission between the time the mission was initiated and the time the FO was in a position to observe (and OT direction sent to the FDC). This FO, therefore, sent "registration" to let the FDC know he is in fact shooting the registration and not a new mission.

Figure 12-3. Record of Fire--registration.

REGISTRATION COMPUTATIONS									
ACHIEVED RANGE					DEFLECTION CORRECTION				
(1) Chart Rg	<u>5060</u> (10M)				(6) Corr Df (Reg)	(1m)			
(2) BP Displ (F-/B+)	(10M)				(5) BP Displ Corr (L+/R-)	(1m)			
(3) Achieved Rg ((1) + (2))	(10M)				(7) Adj Df ((6) + (5))	<u>3320</u> (1m)			
BP DISPLACEMENT CORRECTION					(8) Chart Df	<u>3304</u> (1m)			
(4) Lateral Displ (L/R)	(5M)				(9) Total Df Corr ((7) - (8)) (L+/R-)	<u>L 16</u> (1m)			
(3) Achieved Rg	(10M)				(10) Drift Corr (Adj EI) (L)	<u>L 6</u> (1m)			
(5) BP Displ Corr ((4) - (3)) L/R	(1m)				(11) GFT Df Corr ((9) - (10))	<u>L 10</u> (1m)			
GFT <u>B</u> Chg <u>4</u> Lot <u>YZ</u> Rg <u>5060</u> Ei <u>296</u> Ti <u>17.7</u>					DEFLECTION CORRECTION				
					Total		GFT		
					<u>L 16</u>		<u>L 10</u>		
FADAC RESIDUALS									
SET SETTING									
(5)									

Figure 12-4. Record of Fire--registration (reverse side).

12-9. Second Lot Registrations

Second lot registrations are conducted in much the same manner as are first lot registrations. The procedure is as follows:

a. After the first lot registration has been completed, a time registration is conducted if required.

b. The first round of the second lot registration is fired with the adjusted deflection and the adjusted quadrant elevation determined for the first lot. The adjusted deflection determined for the first lot is also used as

the adjusted deflection for the second lot.

c. The FDC must announce to the observer *OBSERVE SECOND LOT*. The observer must reestablish the appropriate range bracket and complete the second lot registration by using the same procedures as for the first lot.

d. The FDC determines the fuze setting for the second lot GFT setting by applying the total fuze correction from the first lot to the fuze setting corresponding to the adjusted elevation of the second lot.

Section IV. APPLICATION OF REGISTRATION CORRECTIONS

12-10. Checking your Met

Met plays an important part when determining registration corrections. Thus, when a met is received by the FDC it should be

checked for possible errors. The validity of the met should be questioned if any of the below conditions appear in the met message.

a. *Electronic Ballistic Met* (see fig 12-5).

BALLISTIC MET MESSAGE									
For use of this form, see FM 6-15, the proponent agency is United States Continental Army Command.									
IDENTIFICATION	TYPE MSG	OCTANT	LOCATION		DATE	TIME (GMT)	DURATION (HOURS)	STATION HEIGHT (10's M)	MDP PRESSURE (% OF STD PPP)
METB	K	Q	L _a L _a L _a or xxx	L _o L _o L _o or xxx	YY	G ₀ G ₀ G ₀	G	hhh	PPP
METB	3	1	625 468		29	025	0	025	001
ZONE HEIGHT (METERS)		LINE NUMBER ZZ	BALLISTIC WINDS		BALLISTIC AIR				
			DIRECTION (100's MILS) dd	SPEED (KNOTS) FF	TEMPERATURE (% OF STD) TTT		DENSITY (% OF STD) ΔΔΔ		
SURFACE		00	31	04	052		902		
200		01	25	13	048		907		
500		02	30	12	040		914		
1000		03	64	12	019		920		
1500		04	34	13	032		922		
2000		05	36	31	024		911		
3000		06							
4000		07	OVER 1000	OVER	OVER 2%		BOTH		
5000				15 KNOTS			DECREASING		

Figure 12-5. Ballistic met errors.

(1) Drastic changes (over 1000 mils) or sudden reverses of wind direction from line to line; ballistic winds should flow in a fairly uniform manner.

(2) Severe (15 knot) increases or decreases in wind speed from line to line.

(3) Temperature and density changing in the same direction; as temperature increases, density should decrease.

(4) Drastic changes (2% or more) in density or temperature; ballistic temperature and density should change smoothly between zones.

(5) Gross differences in position constants from registration to registration.

(6) Large changes in recorded quantities unless weather conditions have changed; i.e.,

frontal passage, rain/snow, sunrise/sunset, etc.

b. *Electronic Computer Met* (see fig 12-6).

(1) Drastic wind direction changes (over 1000 mils) or sudden reverses in wind direction from line to line.

(2) Abrupt increases or decreases (10-15 knots) in wind speeds.

(3) Difference in identification line pressure and surface pressure (line 00).

(4) Increase in pressure; pressure should decrease smoothly from line to line. Pressure will *NEVER* increase with height.

(5) Severe increase/decrease (over 20 degrees Kelvin) in temperature.

COMPUTER MET MESSAGE								
For use of this form, see FM 6-15, the proponent agency is United States Continental Army Command.								
IDENTIFICATION	OCTANT	LOCATION L _a L _a L _a or xxx L _o L _o L _o or xxx		DATE YY	TIME (GMT) G ₀ G ₀ G ₀	DURATION (HOURS) G	STATION HEIGHT (10's M) hhh	MOP PRESSURE MB's P _d P _d P _d
METCM	Q			YY	G ₀ G ₀ G ₀	G	hhh	P _d P _d P _d
METCM	1	344 982		17	175	0	036	966
ZONE VALUES								
ZONE HEIGHTS (METERS)	LINE NUMBER ZZ	WIND DIRECTION (10's M) ddd	WIND SPEED (KNOTS) FFF	TEMPERATURE (1/10°K) TTTT	PRESSURE (MILLIBARS) PPPP	SHOULD BE THE SAME		
SURFACE	00	310	004	3030	0966			
200	01	249	013	3012	0955			
500	02	316	012	2966	0928			
1000	03	503	013	3199	0886			
1500	04	371	101	2882	0888			
2000	05	455	015	2762				
2500	06							
3000	07	OVER 1000 ft	101 KNOTS,	DRASTIC	PRESSURE			
3500			OBVIOUS	CHANGE	INCREASE			
4000			ERROR					
4500								

Figure 12-6. Computer met errors.

12-11. GFT Settings

a. FADAC-derived GFT setting. The *FADAC-DERIVED GFT SETTING* is simply the association of an achieved range with the FADAC elevation and fuze setting at that range. If the unit has not registered, derived GFT settings to appropriate met check gagepoints may be determined as follows:

- (1) Enter the battery grid as a target in A-1 (TGT EAST) and A-2 (TGT NORTH).
- (2) Subtract 20 meters from the battery altitude and enter the value in A-3 (TGT ALT).
- (3) Enter the azimuth of lay in A-5 (OT DIR).
- (4) Use matrix position A-7(ADD/DROP) to ADD the range at the met check gagepoint.
- (5) Enter the charge in B-1 (CHG).
- (6) Enter flag 7 for fuze time in B-6 (FUZE TYPE).
- (7) Depress the COMPUTE button and copy the quadrant*, time and deflection displayed. These are the adjusted data.
- (8) To obtain another setting, repeat steps (1) through (7) above for a second range (preferably to a second met check gagepoint which is at least 1000 meters from the first point).

*Since site is zero the QE copied is the elevation for the GFT setting.

b. Placing the GFT setting on the GFT fan. Known corrections determined from a registration, computed using a MET + VE technique, or derived using FADAC are portrayed graphically on the GFT or GFT fan in the form of a GFT setting.

(1) One plot setting. A one-plot setting uses one set of known corrections and is placed on the GFT fan in the same manner as it is constructed on the GFT except that the time (TI) and elevation (EL) gagelines are drawn *parallel* to the manufacturer's hairline (MHL).

(2) Two-plot setting. When two sets of corrections from a combination of registration, MET + VE computation, or FADAC derivation are known, a two-plot GFT setting can be constructed. A two-plot GFT setting is *highly desirable* for both the GFT and GFT fan. To construct the two-plot GFT setting on the GFT or GFT fan:

■ Place the MHL over one of the GFT setting ranges and make a black dot on the cursor over the adjusted elevation and a red dot over the adjusted time.

■ Repeat the above step for the second setting.

■ Construct the elevation gageline by drawing on the cursor a fine black line through and connecting the two black elevation dots. Label the line "EL".

■ Construct the time gageline by drawing a fine red line through the two time dots. Label the line "TI" (see fig 12-7).

SEE FM 6-40 FOR MORE DETAILS
ON GFT SETTINGS.

12-12. Deflection Corrections.

a. The deflection correction will be applied using the following procedures:

(1) The *TOTAL DEFLECTION CORRECTION* will be *WRITTEN IN THE UPPER LEFT CORNER* and *CIRCLED* in pencil on both the GFT fan cursor and the GFT cursor. When responsiveness is the primary consideration, the total deflection correction will be applied algebraically to the chart deflection to determine the deflection to fire.

(2) A *GFT DEFLECTION CORRECTION* will be determined and *RECORDED IN THE UPPER RIGHT CORNER*, (in pencil) on both the GFT fan cursor and the GFT cursor. Determine the GFT deflection correction by subtracting the drift correction corresponding to the adjusted elevation from the total deflection correction. The result is the GFT deflection correction.

(3) Example of GFT deflection correction.

Weapon data: GFT 155-AM-1, charge 7,
adjusted elevation 421.

CHART DF	3196
TO ADJ DF	3189
=TOTAL DF CORR	R7
-DRIFT (~ ADJ EL 421)	-(L15)
= GFT DF CORR	R22

THE BACK OF THE RECORD OF
FIRE HAS SPACE FOR THESE COM-
PUTATIONS.

(4) When responsiveness is not of prime consideration, the GFT deflection correction will be algebraically added to the drift correction corresponding to the elevation to determine the total deflection correction.

b. When using a two-plot GFT setting, the total and GFT deflection corrections are determined as follows:

- (1) Total deflection correction
(1st GFT setting)

+ Total deflection correction
(2d GFT setting)

Sum

Sum $\div$ 2 = Total deflection cor-
rection (written on cursor)

(2) GFT deflection correction is determined as in (1) above, substituting GFT deflection correction for total deflection correction.

A DEFLECTION CORRECTION
SCALE WILL NOT BE USED.

12-13. High-Angle GFT Settings.

A high-angle GFT setting may be determined in FADAC using the same procedures as for a low angle derived setting. The only additional requirement is to *ENABLE* the high-angle trajectory matrix 1 location (B-2 on the panel).

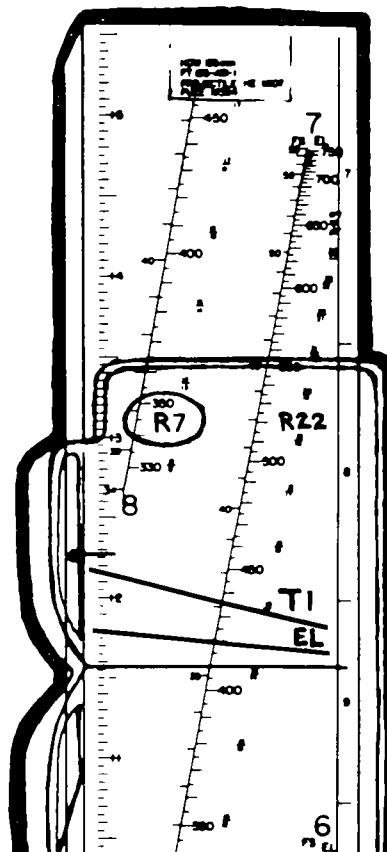


Figure 12-7. GFT fan with two-plot GFT setting, total deflection correction, and GFT deflection correction.

12-14. Offset Registration.

a. A registration from an offset position should normally be conducted by the base piece. Once the registration has been completed, FADAC residuals, a manual GFT setting, and a GFT deflection correction are determined. The GFT setting and GFT deflection correction determined are valid for the offset position within normal range and deflection transfer limits. The same GFT setting and GFT deflection correction are applied at the primary battery position with the following considerations:

- (1) The GFT setting and GFT deflection correction determined at the offset position are based on the azimuth and range from the offset position to the actual registration point. It is assumed that if a registration were conducted at that azimuth and range

from the primary position, the same adjusted data would be determined.

(2) Transfer limits must be inspected to insure that the GFT setting derived from the offset registration is valid for the battery's zone of fire. If not, additional GFT settings should be computed along other azimuths of fire using the 8-directional met technique (see FM 6-40) so that settings are available whose transfer limits adequately cover the zone of the supported unit.

b. If a weapon other than base piece conducts the offset registration, the GFT setting is modified to reflect the difference in shooting strength between the base piece and the registering piece as outlined below. Data are computed on the reverse side of the Record of Fire.

(1) Determine the difference in shooting strength between the registering piece and the base piece.

(2) Determine a VE range correction by multiplying the difference in shooting strength ((1) above) by the muzzle velocity unit correction corresponding to the entry range for the registering piece.

(3) Determine a VE corrected range for the base piece by algebraically adding the VE range correction to the GFT range of the registering piece.

(4) Using the GFT setting for the registering piece, determine the elevation and fuze setting (adjusted data for the nonregistering element) corresponding to the corrected range ((3) above) as follows:

(a) Place the manufacturer's hairline over the range determined in (3) above.

(b) Under the elevation gageline read the adjusted elevation.

(c) Under the time gageline read the adjusted time.

Example: Piece 6 has registered and determined the following GFT setting:

GFT B: Chg 4, Lot YS, RG 5080, EL 320, Ti 18.8. The battery comparative VE for piece 6 is -2.2M/S. The adjusted elevation and fuze

setting for the battery are determined as shown below.

TRANSFER OF GFT SETTING						
①	②	③	④	⑤	⑥	⑦
Bn BP Comp VE	MV Corr Factor D+ 28.0 T- 27.6	MV Rg Corr ① ② =	Achieved Rg (5080)	Corr Rg ③ + ④ =	El ~ ⑤ Use El / (Gageline)	Ti ~ ⑥ Use Ti / (Gageline)
M/S	M	10M	10M	10M	m	FS
B 12.2*	-21.6	-50	5080	5030	316	18.5

*Since piece 6 has a comparative VE of -2.2M/S, then the BP shooting strength is 2.2M/S greater than that of piece 6.

12-15. Registration to the Rear.

a. Registering to the rear (or at some azimuth significantly different than the primary azimuth of fire) will result in a GFT setting which does not include the primary azimuth of fire within its deflection transfer limits.

b. To derive a GFT setting for the primary azimuth of lay apply 8-direction met techniques:

(1) Determine position corrections by working a concurrent met for the registration azimuth.

(2) Determine total corrections (in the direction of the azimuth of lay) by reworking the met using subsequent met techniques. (See FM 6-40 for 8-directional met techniques.)

12-16. Recomputation of GFT Settings When Survey Becomes Available.

a. *General.* Field artillery units must be able to deliver responsive, accurate fires immediately upon occupation of a new position. Firing must not be delayed because of a lack of survey or suitable maps. The firing chart may be a surveyed (map spot or actual survey) or an observed firing chart. Once actual survey is brought into the battery area, the firing charts must be reconstructed based on the battery's true location and true azimuth. GFT settings based on map spot or OF charts must be recomputed.

b. Manual Computations.

(1) The GFT setting is recomputed on the basis of the new surveyed firing chart data. Although the adjusted QE and time remain the same, the new chart data will cause the GFT setting to change.

(2) The GFT setting is recomputed as follows:

STEP 1: The new chart range to the registration point becomes the new GFT setting range.

STEP 2: Recompute *SITE* based on the new chart range and vertical interval.

STEP 3: Algebraically subtract the recomputed site from the adjusted quadrant elevation (QE) to determine the new *ADJUSTED ELEVATION*.

STEP 4: Determine the new *TOTAL* deflection correction by comparing the new chart deflection to the adjusted deflection.

THE ADJUSTED TIME WILL NOT CHANGE, SINCE IT WAS ACTUALLY DETERMINED BY FIRING.

THE ADJUSTED DEFLECTION REMAINS THE SAME BECAUSE THE BATTERY IS NOT RELAI.

STEP 5: Determine *DRIFT* corresponding to the new adjusted elevation.

STEP 6: Determine the new *GFT DEFLECTION CORRECTION* by algebraically subtracting the drift corresponding to the adjusted elevation (step 5) from the total deflection correction (step 4).

c. Sample problem (manual).

(1) Survey has been completed and the following information has been given to the FDC:

Battery Center . 5857239598 ALT 328
Registration Point 3 6459538711 ALT 364
Azimuth to the end of
the Orienting Line 4175

Known Data

155mm Howitzer (M109A1) Battery
Orienting Angle 2450
Grid Declination 18 mils East
Latitude 35° North
All other data standard
GFT Setting (based on a map spot battery location)
GFT B: Chg 4, Lot XY, Rg 6240, El 428, Ti 24.4
Total Df Corr L22
GFT Df Corr L12
Adjusted QE 432
Adjusted Deflection 3184

(2) Based on the above information, the surveyed firing chart is reconstructed as follows:

(a) The surveyed locations of the battery center and registration point 3 are plotted.

(b) Deflection indexes are constructed based on the corrected azimuth of lay, which is determined as follows:

AZIMUTH TO EOL	4175
-ORIENTING ANGLE	2450
=AZIMUTH OF LAY	1725

(3) Now that the surveyed firing chart has been reconstructed, chart data to registration point 3 are remeasured.

CHART RANGE	6090
CHART DEFLECTION	3174

(4) The GFT setting must now be recomputed based on the correct chart data.

STEP 1: *THE REMEASURED CHART RANGE*, 6090, becomes the new GFT setting range.

GFT B: Chg 4, Lot XY, Rg 6090---

STEP 2: Using the new chart range and *VI*, recompute *SITE*.

ALTITUDE REGISTRATION POINT 3	364
-ALTITUDE BATTERY	328
=VERTICAL INTERVAL	+ 36

SITE = +7 (+36/RG 6090, CHG 4, TAG)

STEP 3: Determine the *ADJUSTED ELEVATION*.

ADJUSTED QE	432
-SITE	-(+7)
ADJUSTED ELEVATION	425

GFT B: Chg 4, Lot XY, Rg 6090, El 425, ---

Since the adjusted time does not change, it is brought forward.

GFT B: Chg 4, Lot XY, Rg 6090, El 425,
Ti 24.4

STEP 4: Redetermine the *TOTAL DEFLECTION CORRECTION* by comparing the new chart deflection to the adjusted deflection.

CHART DF	3174
TO ADJUSTED DF	3184
TOT DF CORR	L10

STEP 5: Determine *DRIFT* corresponding to the adjusted elevation, 425.

DRIFT ~ EL 425 = L9

STEP 6: Determine the new *GFT DEFLECTION CORRECTION* by algebraically subtracting drift corresponding to the adjusted elevation from the total deflection correction.

BATTERY CENTER	
REGISTRATION POINT 3	
CORRECTED AZIMUTH OF LAY	

TOTAL DEFLECTION CORRECTION	L10
-DRIFT (ELEVATION 425) - (L9)	
=GFT DEFLECTION CORRECTION	L1

The complete GFT setting has now been re-computed:

GFT B: Chg 4, Lot XY, Rg 6090, El 425,
Ti 24.4

GFT DF CORR: L1

d. *FADAC procedures.*

(1) Once the surveyed grid locations and altitudes of the battery and the registration point and the azimuth of lay have been accurately determined, they are entered into FADAC.

(2) Registration corrections must be re-computed and applied. Since survey has established the correct center and registration point locations and the azimuth of lay, registration corrections are re-computed on the basis of those corrected data and using the known adjusted did-hit data to the registration point.

(3) Known data provided by survey are--

<u>EASTING</u>	<u>NORTHING</u>	<u>ALTITUDE</u>
58572	39598	328
64595	38711	364
1725		

(4) Registration corrections are re-computed and applied as follows:

<u>STEP</u>	<u>ACTIVATE BUTTON OR MATRIX LOCATION</u>	<u>KEYBOARD</u>
1	E-2 SET UP	SET UP BUTTON
2	H-1 BTRY EAST	SM; 58572; ENTER
3	H-2 BTRY NORTH	SM; 39598; ENTER
4	H-3 BTRY ALT	SM; 328; ENTER
5	H-4 BTRY AZ LAID	SM; 1725; ENTER
6	H-5 BTRY DF	SM; 3200; ENTER
7	A-1 TGT EAST	SM; 64595; ENTER
8	A-2 TGT NORTH	SM; 38711; ENTER
9	A-3 TGT ALT	SM; 364; ENTER

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10	E-3 TGT STORE	SM; 100;	ENTER
11	B-1 CHG	SM; 4;	ENTER
12	B-6 FUZE TYPE	SM; 7;	ENTER
13	G-6 DF INPUT	SM; 3184;	ENTER
14	G-7 TI INPUT	SM; 24.4;	ENTER
15	G-8 QE INPUT	SM; 432;	ENTER
16	COMPUTE	NONE	

DISPLAY:

<u>BATTERY</u>	<u>CHARGE</u>	<u>DEFLECTION</u>	<u>TIME</u>	<u>QUADRANT ELEVATION</u>
----------------	---------------	-------------------	-------------	-------------------------------

B	4	3185	22.8	391
---	---	------	------	-----

17	H-8 COMP REG	SM
----	--------------	----

(5) Residual registration corrections are displayed as follows:

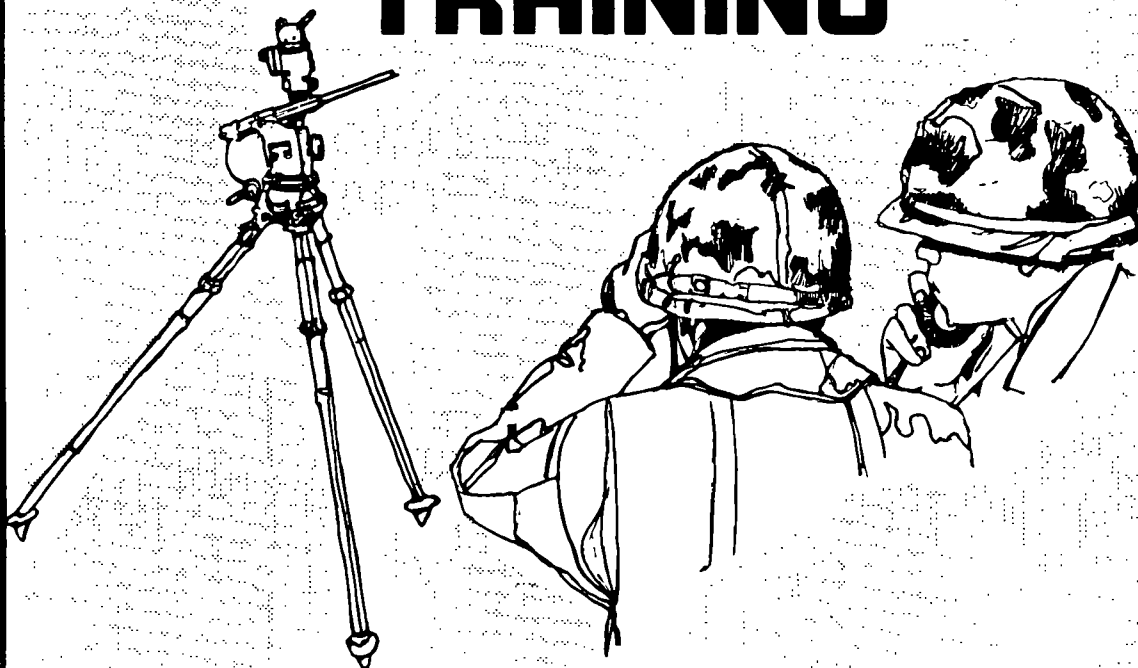
<u>DEFLECTION</u>	<u>TIME</u>	<u>RANGE K</u>
+(R)2	9(-)0.9	(+)80

18	H-8 COMP REG	4; ENTER: (.); ENTER
19	E-1 EOM	SM; 0

**For this example only we have SET UP to put MET, registration corrections and other elements to standard or zero values.*

PART FIVE

TRAINING



CHAPTER 13

HOW TO TRAIN FO AND FDC SECTIONS



CHAPTER 13

HOW TO TRAIN FO AND FDC SECTIONS

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Section I. THE PERFORMANCE-ORIENTED APPROACH TO TRAINING

13-1. General

a. We must be prepared for an all-out, winner-take-all fight. Our success in this environment will depend heavily on the quality of our weapons and the superiority of our tactics and techniques. Of even more importance will be the proficiency of our soldiers and units. *WE MUST HAVE A FIRST-RATE, WELL-TRAINED ARMY THAT FIGHTS AND WINS AS A TEAM.*

Our weapons, tactics and techniques will be effective in combat only to the extent that we train our soldiers to exploit their full capabilities.

Our soldiers must be convinced — totally convinced — that we can win on the modern battlefield. This confidence can only come from training. Therefore, above all else, we must find ways to train in peacetime which will improve the effectiveness of our forces in combat.

b. We must train the way we are to fight. To meet the challenge of surviving and winning on the battlefield, we must be more competent and professional. Our options are few, the risks are great, and time is short. *TRAINING* must become our *NUMBER ONE PRIORITY*. It must be conducted under the conditions we expect to find on the modern battlefield. This means that our field artillery training must be coordinated and executed with maneuver units in combined arms exercises and evaluations. Our primary objective is to develop a well-trained combined arms team. *NO MISSION IS MORE IMPORTANT THAN THIS!*

c. The purpose of training is *PREPARATION FOR JOB PERFORMANCE*. The question, "Does this training really prepare the soldiers to do their job?", should become your guide as you prepare training.

d. This chapter explains how to use the *PERFORMANCE-ORIENTED APPROACH* in training forward observers (FO) and fire direction center (FDC) sections. The

flexibility of the approach makes it especially useful in what has been called the "hostile training environment" (ammunition shortages, malassignment, guard duty, etc.). The ideas are based on the training framework set forth in FM 21-6, *How to Prepare and Conduct Military Training* (November 1975).

13-2. Training Managers

a. *TRAINING MANAGERS* are responsible for the planning, organization, conduct, and evaluation of training. Battalion commanders are the principal training managers. However, battery commanders (BC's) also manage training.

b. The manager's role is to employ available resources to develop training programs which insure that individuals and units can perform their tactical and administrative missions.

13-3. Trainers

TRAINERS prepare, conduct, and evaluate training. Whereas the training manager *establishes* the training objectives which are critical to the accomplishment of his mission, the trainer is responsible for *accomplishing* one or more of these objectives.

13-4. Training Objective

It is only a slight exaggeration to say that the performance-oriented approach to training begins and ends with the *TRAINING OBJECTIVE*. For a given skill, a properly structured and completed training objective is both the training and the test. A properly constructed training objective consists of three elements:

- TASK to be performed.
- CONDITIONS under which the task is to be performed.
- STANDARDS of acceptable performance.

13-5. Individual Training

a. Individual training prepares individuals to perform the specific tasks related to an assigned MOS and duty position.

b. Soldier's Manuals provide the basis for individual training and evaluation. Each manual specifies, by MOS, skill level, and duty position cluster, the critical combat tasks each soldier is expected to perform. Soldier's Manuals include the minimum standards of performance and are the basis for the Skill Qualification Test (SQT). This is a performance test, administered periodically, which permits a soldier to demonstrate proficiency in his present MOS and skill level and to qualify for advancement to the next higher skill level.

c. The importance of the NCO in the training process cannot be overstated. In most cases, the NCO is the one who will normally conduct individual training, monitor progress, and evaluate proficiency.

13-6. Collective Training

a. Collective training prepares soldiers to perform team or unit tasks essential to the accomplishment of a unit's mission.

b. Army Training and Evaluation Programs (ARTEP's) assist training managers and trainers in the preparation, conduct, and evaluation of "collective" training. Each ARTEP is comprised of a series of training and evaluation outlines. Each outline specifies for a particular element of a battalion or battery the following information:

(1) The element (e.g., section, battery, or battalion) for which the outline is applicable.

(2) The task to be performed.

(3) The general conditions (situation) under which the task will be performed.

(4) The minimum standards to which the task must be performed.

TRAINING TIP

The new user of the FA Battalion ARTEP should immediately distinguish between section (howitzer, forward observer, Bn FDC) and delivery-of-fires training outlines:

- Delivery of fires training outlines include conditions under which the entire battery or battalion must deliver fires—along with time and accuracy standards. They are used for formal evaluation.
- Section outlines include conditions and standards which individual sections can use to train—usually independent of the rest of the unit. They may be used in formal evaluations.

c. The FDC section trainer (for collective training) is normally the FDO. The FO section trainer is normally the senior FO.

13-7. The Training Manager's Role

a. The commander (training manager) analyzes his situation, his assigned missions, and the ARTEP in determining where his unit should go in training. The ARTEP systematically lists the *TRAINING OBJECTIVES* which a unit must perform to insure accomplishment of its combat mission.

b. Once training objectives are established, the commander must *EVALUATE* the current level of individual and unit proficiency for each listed training objective. To make this determination the commander may use among other things:

- (1) ARTEP results.
- (2) SQT (MOS test) results.
- (3) Personnel and weapons qualification records.
- (4) Field exercise after action reports.
- (5) Subjective evaluation.

Note. Care must be taken to determine any actual weakness that may exist. For example, an adjust fire mission that is not accomplished in the prescribed time could indicate training weakness in any of several sections (FO, FDC, and/or howitzer). Normally, failures at the battery level indicate a need for additional emphasis at section or individual level.

c. Having identified appropriate training objectives and evaluated the current level of individual and unit proficiency, the commander determines the training required and establishes the *TRAINING PROGRAM*. He must issue "specific training guidance" to his trainers. This guidance should consist of the following elements:

(1) One or more specific *TRAINING OBJECTIVES*.

(2) *WHO* is to be trained; *WHEN* and *WHERE* training is to be conducted.

(3) The *REASONS* why the training is necessary.

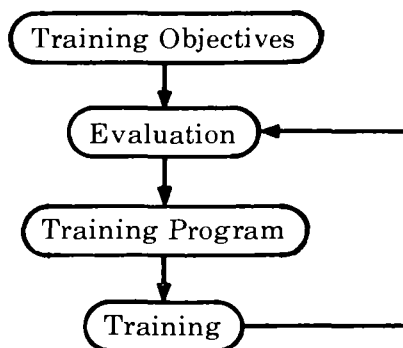
(4) Training *RESOURCES* available.

d. Once the training guidance has been issued, the trainer can conduct the *TRAINING*. The commander should then monitor training to insure that:

(1) Training objectives are being accomplished.

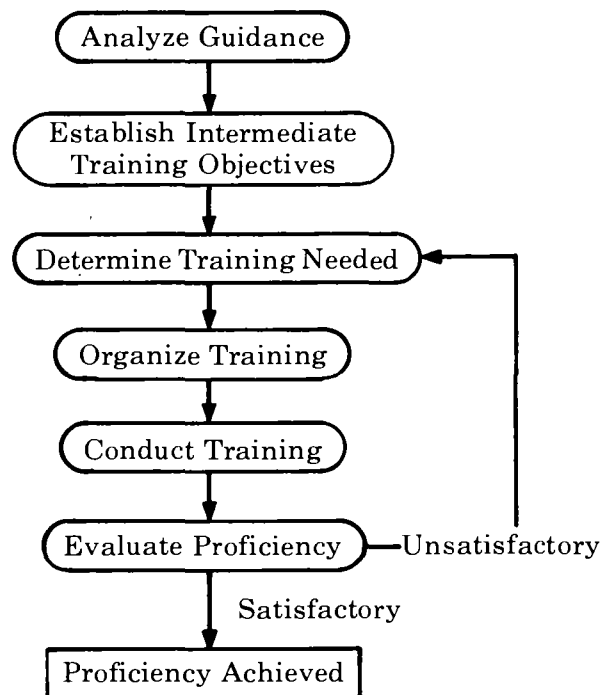
(2) Major unit missions will then be accomplished.

The following diagram describes the process.



13-8. The Trainer's Role

a. The flow chart below shows how a trainer accomplishes his assigned training objectives.



b. Let's look closely at each step:

(1) If the trainer receives incomplete or vague training guidance, he must *ANALYZE* that guidance. He should ask his commander questions which will help both of them focus on what is expected of soldiers at the completion of training. These questions may include:

(a) *WHAT* specific training objectives do you want accomplished?

(b) To *WHOM* will the training be given?

(c) *WHEN* will the training take place?

(d) *WHERE* will the training take place?

(e) *WHY* did the commander decide to conduct the training?

(f) *HOW* can necessary resources be obtained?

(2) The trainer may often find it useful to break complex training objectives down into simpler *INTERMEDIATE TRAINING OBJECTIVES*. The current proficiency of those to be trained will determine just how simple these intermediate objectives are. Very basic tasks should result only when proficiency is low. Trainers must develop standards for intermediate objectives which insure that the commander's training objectives are met.

(3) The trainer determines what training is needed by testing to determine if individuals can perform intermediate training objectives to specified standards. Using these objectives as tests will serve as a basis for determining what training each soldier actually needs.

(4) A trainer organizes training by:

(a) Determining the order in which objectives/intermediate objectives are taught.

(b) Estimating the resources required.

(c) Completing administrative requirements (obtaining equipment, preparing lesson outlines, etc.).

(5) In performance-oriented training, lectures and conferences are held to a minimum. The bulk of training time is devoted to the *CONTROLLED PRACTICE OF A TASK*. The performance-oriented approach lends itself to a training session (a class or block of instruction) consisting of three phases:

PHASE I: The trainer states the purpose of the training and explains or demonstrates how the task will be performed. This part should be as brief as possible.

PHASE II: The soldiers *PRACTICE* the task (under NCO supervision) to acquire the degree of proficiency required by the training standard.

PHASE III: The soldiers are tested by performing the task (to established training standards) under NCO supervision. Those who meet standards can proceed to another activity; those who do not should be critiqued

on mistakes and continue practicing. It may be necessary for trainers to demonstrate performance of tasks again. Successes and failures of individuals should be recorded by the section NCO in an informal training record.

(6) It may be necessary to organize additional training for those who are unable to complete training objectives in regular training sessions. This training should be specifically aimed at those tasks which have not been accomplished to standards.

Note. The Field Artillery School has developed a considerable amount of training material for use by units in the field. The paragraphs which follow will reference these materials and explain how you can order them and use them to support your training.

13-9. The Field Artillery Catalog of Instructional Material and the USAFAS Correspondence Course Catalog

a. One of the most worthwhile sources of instructional material for establishing a viable training program is the Field Artillery Catalog of Instructional Material. This catalog may be obtained by writing:

Commandant
USAFAS
ATTN: ATSF-DT-FSEX
Fort Sill, OK 73503

Among the materials listed in the catalog are:

(1) Class packets. These materials may be used for individual, section, unit, and MOS-related training. A typical lesson contains three different packets:

(a) Instructor's packet - includes the lesson plan manuscript, one set of student materials, demonstration-size copies of forms used, and mailable training aids.

(b) Slide packet - includes the Vu-Graph transparencies referenced in the lesson plan manuscript.

(c) Student packet (materials for 5 students) - includes instructional notes and writs, workbook chapters, reference notes, practical exercises, and required training

aids or devices.

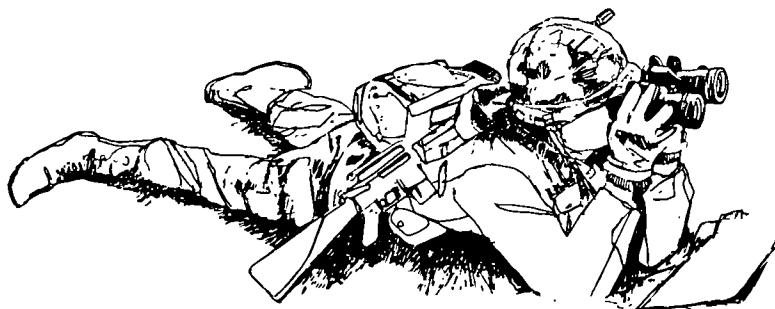
- (2) Programed texts.
- (3) Video tapes.

b. The USAFAS Correspondence Course Catalog contains a complete listing of all correspondence courses available through the Field Artillery School. Copies of this

catalog may be obtained by writing:

Commandant
USAFAS
ATTN: ATSF-SE-R
Fort Sill, OK 73503

Make use of training materials available through the Field Artillery School.



Section II. HOW TO TRAIN

13-10. General

a. Ammunition availability will not permit frequent, full-scale, live-fire exercises. However, a considerable amount of evaluation and training can take place without ammunition. FDC proficiency can be assessed using the firing battery headquarters portion of the ARTEP which requires no live-fire; many FO tasks can be evaluated without ammunition. Many firing tasks can be evaluated using the M31 Field Artillery Trainer. Let's join a BC who plans to evaluate his unit's level of proficiency.

... Our battery will participate in a battalion formal (ARTEP) evaluation in three months. I've reviewed records, but I don't have a good handle on how we stand now. Accordingly, we're going to take a mini-ARTEP on the new 14.5 range. Since our range is new, LT Jones will work up specific problems for the FO missions and LT Roberts will work up problems for the FDC missions. We have a 14.5 FADAC tape, so we can evaluate both FADAC and manual capability. This exercise will prepare you trainers to conduct training once the evaluation is complete.

b. Having used the *MINI-ARTEP* to identify training objectives his unit is unable to complete, the commander can incorporate these objectives into his unit training program by issuing specific training guidance to his trainers.

13-11. The FO Trainer

a. Based on the results of his *MINI-ARTEP* and discussion with maneuver commanders, our battery commander has identified that his forward observers are having difficulty locating targets as well as locating themselves. He gives the following guidance to his senior FO who has been designated the trainer.

(1) REASON WHY TRAINING IS NECESSARY:

LT Jones, we've been getting complaints from the maneuver types about our FO's becoming misoriented during combined-arms training. Some FO's had considerable difficulty associating map and terrain on the *MINI-ARTEP*. Our people need work in this area.

(2) TASK:

Each FO and recon sergeant must be able to locate himself and targets which present themselves.

(3) CONDITIONS:

They will be checked out at each of 12 designated points along a 6000 meter "terrain walk". At each point, they will be required to locate themselves and one target. Of the 12 targets an individual must locate, I want 3 targets located by each of the three standard methods and 3 by hasty shift from a planned target — all targets are to be at 2000-5000 meters distance. Each individual is to be given a compass, binoculars, and map.

(4) STANDARD:

I want standards tougher than those in the *ARTEP*. Observers must locate themselves in 30 seconds or less to within 100 meters of their actual location. Target location standards are as follows:

GRID, POLAR PLOT, and SHIFT — within 200 meters of actual location in 45 seconds. HASTY SHIFT — select nearest compass point and locate target to within 300 meters in 15 seconds.

(5) WHO, WHEN, WHERE:

All FO's and recon sergeants, 1200-1700 hours 25 September (two weeks from now) in training area K.

(6) RESOURCES:

Assistant trainers will be SSG Brown and SGT Fox. You'll have five hours for training. See the Bn S-2 for 1:50,000 maps of the training area and the Bn S-4 for transportation. Check with Third Brigade to see if they want their mortar observers included in this training.

b. The trainer analyzes the BC's guidance to be sure he understands what is expected. In this example, the commander has properly discharged his training responsibility; he has told the trainer precisely what he wants FO's to be able to do at the completion of training.

The BC may very well establish training standards more stringent than those found in the ARTEP.

c. Drawing upon his own experience, the trainer identifies several simpler tasks which the trainees must be able to perform.

(1) Determine own location by map-terrain association.

(2) Determine observer-target (OT) direction.

(3) Determine direction from a known point to various targets.

(4) Estimate distance.

(5) Measure angular deviation using binoculars.

(6) Determine lateral shift using the mil relation.

(7) Determine grid coordinates by polar plot combined with map-terrain association.

The trainer then develops training standards and conditions for these tasks.

Here are some examples.

TASK (2): Each FO must determine OT direction.

CONDITION: given a designated observable point at 1000 to 5000 meters and a compass.

STANDARD: to within 20 mils in 10 seconds or less.

TASK (6): Each FO must determine lateral shift,

CONDITION: given binoculars and a 1:50,000 map

STANDARD: to within 20 meters in 30 seconds or less.

d. The trainer determines how much training is needed by testing to see if individuals can perform the objectives. If all personnel are proficient in the objectives, e.g., use of the compass, then that intermediate objective may be eliminated from training. However, those that are not proficient in the objective must be trained.

TRAINING TIP

Skill in range estimation and map-terrain association are rapidly lost — conduct frequent refresher training.

e. Actual training should be set up using the three-phase performance-oriented training procedures. Training on task (2) would go like this:

PHASE I: The trainer (or assistant trainer) states the purpose of determining accurate OT direction and demonstrates the use of the compass.

PHASE II: Soldiers practice determining OT direction under the conditions specified until the standard can be met.

PHASE III: Soldiers are tested by performing the objectives to standards. Those who are successful move to another station to practice another objective. Those are unsuccessful continue working with the compass. The trainer should record successes and failures so he can organize additional individual training as needed. Such an informal record might look like figure 13-1 below.

NAME	TASK					
	LOCATE SELF	DETERMINE DIR	ESTIMATE DIS	MEASURE DEVIATION	DETERMINE SHIFT	LOCATE TARGET
SGT Smith			X	X	X	
SGT Farewell	X	X	X	X	X	X
PFC Shea	X	X	X	X		X
X = proficient						

Figure 13-1. Informal training record.

f. Our trainer has determined that SGT Smith is experiencing difficulty in both locating himself and using the compass. He states to him:

SGT SMITH, I WANT YOU TO GET SUBCOURSE FA 465, BASIC MAP READING, FROM OUR UNIT LIBRARY AND WORK IT BY THURSDAY AFTERNOON. FRIDAY MORNING, YOU AND TWO PEOPLE FROM C BATTERY WILL GO WITH SSG BROWN ON A SHORT TERRAIN WALK. YOU'LL BE TESTED AT THE END TO SEE IF YOU'VE IMPROVED.

Note. Subcourse FA 465 is listed in the USAFAS Correspondence Course Catalog. Friday afternoon, SSG Brown reports to the trainer that SGT Smith is now able to successfully accomplish the self-location training objective.

The trainer has also noted that PFC Shea is having difficulty determining target locations by shift from a known point.

PFC SHEA, HERE IS A PROGRAMED TEXT ON TARGET LOCATION: COMPLETE IT BEFORE LUNCH.

Note. Programed Text -2E0616001A, Observed Fire, Target Location, is found in the Field Artillery Catalog of Instructional Material.

After additional training, some individuals still may be unable to accomplish intermediate training objectives.

PFC SHEA, YOU'RE STILL HAVING TROUBLE COMPUTING A SHIFT. AT 1330 GO SEE SGT FOX FOR SOME ADDITIONAL INSTRUCTION USING TEC LESSONS.

Note. TEC Lessons are indexed in TC 21-5-4, Catalog of Training Extension Course Lessons.

This process continues until proficiency is achieved.

13-12. The FDC Trainer

a. In reviewing the results of the last battalion field exercise, our BC has identified a weakness in the FDC. Accordingly, he issues training guidance to his FDO.

(1) REASONS WHY TRAINING IS NEEDED:

LT Roberts, on the last field exercise, the FDC failed to meet the time and accuracy standards for high angle missions. We can't meet first round time standards if we use FADAC for initial data, so we're going to have to work on computing high angle data manually.

(2) TASK:

Your FDC must compute firing data for an adjust fire, high angle mission using fuze quick.

(3) CONDITION:

An observer has just requested high angle fire on a target in defilade. Site must be included.

(4) STANDARD:

Initial round data must be computed within 45 seconds after FDC receives the complete call for fire; subsequent data within 25 seconds. Meet this standard in 10 days. Rotate personnel — conduct some cross training.

(5) WHO, WHEN, WHERE:

You'll train Battery A FDC personnel during scheduled FDC training over the next 10 days in the battery area.

(6) RESOURCES:

You'll have 18 hours of FDC training time in the next 10 days, but your computer will be on leave for the first five days.

b. Our FDO knows that the reason for the poor showing on the high angle missions is low individual proficiency. He uses the Soldier's Manual to test the individuals in the FDC on specific individual tasks and determines that training is needed on the following tasks:

(1) Use of GST to determine angle of site.

(2) Computation of high angle site.

(3) Computation of deflection.

(4) Use of the high angle GFT.

(5) Inferring a high angle GFT setting from FADAC.

c. The FDO knows that the computer will be on leave during the first five days of training, so he decides to conduct individual training as well as cross training during those days. He arranges his training schedule so that tasks progress logically and uses the three-phase technique to plan training. Figure 13-2 below shows what a portion of his schedule might look like.

SUGGESTED TRAINING FOR DAY 1 0730-0835

PHASE	ACTIVITY	TIME	STANDARDS
I	State training objective and demonstrate use of GST to determine angle of site.	20 min	—
II	Practice with GST to determine angle of site.	35 min	Correct to nearest mil within 5 sec.
III	Test individual's ability to meet training	10 min	See above standard.

SUGGESTED TRAINING FOR DAY 1 0835-1100

PHASE	ACTIVITY	TIME	STANDARDS
I	State training objective and demonstrate computation of high angle site.	25 min	—
II	Practice computing high angle site.	45 min	Correct to nearest mil within 10 sec after VCO announces angle of site.
III	Test individual's ability to meet training standards.	15 min	See above standard.

Figure 13-2. Suggested schedule of training for day 1.

This process should continue through all intermediate training objectives. When the computer returns from leave, he may have to brush up on his own before the FDC will be ready to conduct full-section drill. TEC lessons are well suited to that purpose. Figure 13-3 below illustrates the use of TEC lessons for both evaluation and training.

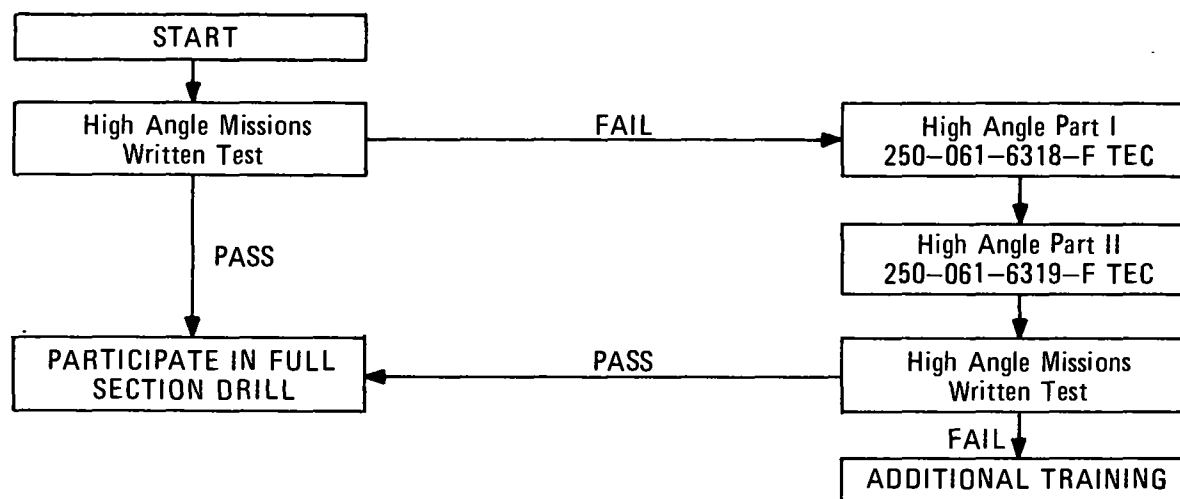


Figure 13-3. Use of TEC with FDC.

d. The trainer's record of individual proficiency (fig 13-4) helps him organize additional training. Let's see how the FDO uses available resources to bring members of his FDC up to standards.

TASK	Angle of Site	Computation of Site	Computation of Deflection	Use of HA GFT	Infer GFT Setting
Johnson (Cmptr)	X	X	X	X	X
Harshman (HCO)	X	X	X	X	X
Scott (VCO)	X	X	X		
Braddock (RTO)	X	X	X		X

X = proficient

Figure 13-4. Record of individual proficiency.

(1) The VCO and RTO are both having difficulty using the high angle GFT. The FDO decides to use a video tape to supplement the training in this area. He addresses the VCO and RTO:

CHECK OUT VIDEO TAPE NUMBER -2E/041-061-0384-B, HOW TO READ A HIGH ANGLE GFT. WATCH THE TAPE AT LEAST TWICE. WHEN YOU COMPLETE THAT, COME BACK AND SEE ME.

Note. This tape is listed in the Field Artillery Catalog of Instructional Material.

(2) The RTO still can't meet the FDO's time standard in reading data from the GFT. The FDO says to him:

HERE IS A COPY OF REFERENCE NOTE GD-DU, HIGH ANGLE FIRE. READ THE NOTE AND WORK THESE FIVE PROBLEMS IN THE GUNNERY WORKBOOK. A LITTLE MORE PRACTICE AND YOU'LL HAVE THAT TIME UNDER FIVE SECONDS.

Note. Reference Note GD-DU is part of class packet GDXXDU, listed in The Field Artillery Catalog of Instructional Material. This packet also contains a gunnery workbook on high angle fire.

(3) The VCO does not understand how to infer a high angle GFT setting from FADAC. The FDO says:

SPECIALIST SCOTT, WATCH THIS VIDEO TAPE. IT COVERS DETERMINATION OF A LOW ANGLE GFT SETTING — HIGH ANGLE IS VERY SIMILAR. WHEN YOU FINISH WATCHING THE TAPE, I'LL EXPLAIN THE DIFFERENCES TO YOU.

Note. Video tape -2E/041-061-0408-B, How to Obtain a GFT Setting From FADAC, is listed in the Field Artillery Catalog of Instructional Material.

The trainer has many different kinds of instructional material available to help him bring FDC personnel up to standards. If visual aids such as video tapes are unsuccessful, he can use written problems. As has been mentioned before, a complete list of such material is in the FIELD ARTILLERY CATALOG OF INSTRUCTIONAL MATERIAL and the USAFAS CORRESPONDENCE COURSE CATALOG.

Section III. THE M31 FIELD ARTILLERY TRAINER

13-13. General

a. Imaginative use of time, ammunition, personnel, and training aids is essential to the achievement of combat readiness. The BC addresses his key personnel:

GENTLEMEN, MANY OF YOU HAVE BEEN USING THE M31 TRAINER TO ACHIEVE PROFICIENCY IN FO, FDC, AND HOWITZER SECTIONS. NOW WE'RE GOING TO PUT THE BATTERY ALL TOGETHER IN ANOTHER 14.5 MINI-ARTEP TO SEE HOW MUCH OVERALL IMPROVEMENT WE'VE MADE.

The M31 is an effective tool for developing teamwork and technical proficiency at individual, section, and unit levels. Ammunition saved by using the M31 can be used to support combined arms live-fire problems and the evaluation phase of the ARTEP.

b. M31 trainer kits include material for firing from either a tripod or the bore of a howitzer. Also included are FDC graphical equipment and an M31 FADAC tape. These training kits allow realistic training of fire direction personnel, forward observers, gun crews, survey teams, and maneuver unit leaders — all in limited space and at a low cost.

Save your training ammunition by using the M31 in training the field artillery team.

13-14. Using the M31 to Train FO's

a. Individual training with the M31 offers tremendous possibilities for the observer section. It can be used to effectively train maneuver leaders as well. The more realistic the M31 range, the greater will be the benefits derived from training. To gain full benefit, the range should have:

(1) Challenging terrain for impact areas.

There should be considerable terrain variation as the observer moves. It is best to develop the impact area in the bottom of a bowl-shaped piece of terrain which permits observation from all sides of the range.

(2) Accurate 1:5000 scale maps with grid lines 100 meters apart so observers can use normal observed-fire (OF) fans and coordinate scales.

(3) Realistic targets which allow observers to practice target identification concurrent with other training. Local Training Aids Support Offices (TASO's) can provide information on how to obtain 1/10th scale, Warsaw Pact-style targets.

b. The following techniques can be used to develop FO skills:

(1) Train the observers to engage moving targets with indirect fire by use of the range-pulley system. Keeping the 1-to-10 scale of the range in mind, the observer can do the following:

(a) Estimate the speed of the target.

(b) Calculate intercept points along the route.

(c) Call for time-on-target (TOT) missions at intercept points.

During these missions, the FDC should receive training in coordinating TOT's. The FO/FDC team must strive to reduce the time elapsed from the time the FO sent in the requirements for the TOT until the unit is ready to fire.

(2) Train the FO to shoot at dissipating targets by use of a "wired" impact area.

The instructor can activate any device and advise the FO that the explosion represents for example, a SAGGER missile firing, a weapon muzzle flash, or a rocket signature.

(3) Practice coordinated illumination/HE missions by illuminating the target area with handheld flares and by firing the M31 underneath the flares. Coordination techniques can be developed by requiring the FO to call for the illumination just as he would in live-fire exercises. The flares should be fired from a position some distance away

from the FO to add realism to the exercise.

(4) Change target locations on the range frequently. Such changes will prevent the FO from memorizing the target locations after several trips to the range. Changes will also cause him to associate the target location with the terrain each time he calls for fire.

(5) Keep use of static OP's to a minimum. FO's should move laterally and in depth between rounds and between missions. This creates a realistic observer situation with terrain aspect, angle-T, and OT direction continually changing.

(6) The following types of missions cannot be practiced with the M31:

(a) Missions employing fuze time.

(b) Smoke or white phosphorus missions.

(c) Fuze VT missions.

(d) Adjustment of illumination height of burst.

(e) AN/MPQ-4A Radar training (the projectile is too small).

13-15. Using the M31 to Train FDC's

a. The training manager can conduct more efficient training by training both observers and FDC concurrently.

b. FDC Procedures.

(1) Manual solution.

(a) The 1:25,000 scale grid sheet is set up in the normal manner except that the space between grid lines is 1,000 decimeters.

(b) The target grid is used in the normal manner. The HCO plots targets using the standard coordinate scale and determines chart data using the standard scale range-deflection protractor. The VCO determines site using the special map and the 14.5mm GST.

(c) Meter differences in altitude require a quick conversion to decimeters. For example, if the difference in altitude is 5 meters, the VCO would use 50 decimeters as the vertical interval (VI) and the range an-

nounced by the HCO to compute site. Instructions and examples on GST usage are printed on the back of the GST. The computer, using the 14.5mm GFT, computes the gun data and announces the fire commands to the guns.

(d) Because of the short range of the 14.5mm trainer, small vertical differences, such as one or two meters, equate to several meters in range. Therefore, in order to obtain valid corrections when conducting a registration, the height of the barrel above the surveyed battery center should be considered. When constructing a firing chart, the surveyed altitude of the battery should be increased by the following amount.

Model	Howitzer	Decimeters
M101A1	105mm	+10
M102	105mm	+10
M114A1	155mm	+15
M109/M109A1	155mm	+20
M110	8-inch	+20

(2) FADAC solution. A revision 5 FADAC tape and instruction book is available as part of the FADAC kit. The kit contains all the needed information for set up and use of the FADAC with the 14.5mm cannon program. It contains sample problems and solutions for ready reference.

13-16. Unit Training with the M31

a. The reduced scale of the M31 range is really a plus for the unit commander. He can move quickly from FO's, to guns, to FDC, and to survey sections to supervise activities,

to troubleshoot, or to solve problems that may develop during training. Since much of this movement can be on foot, the commander does not have to spend valuable time on the road moving from one point to another. If necessary, the commander can very quickly assemble his entire unit to critique events or to set the stage for subsequent training activities.

b. Sections function better if each member understands how the unit works as a whole. During M31 training, members of the gunnery team can be moved quickly to other locations so they may observe the activities of the other elements. This technique is particularly valuable in the early stages of unit training.

c. Many special-unit techniques can be practiced on the M31 range just as in live-firing. For example:

(1) Roving-gun techniques are just a valid in M31 exercises as in live-fire exercises.

(2) Massed fire and TOT procedures for the delivery of suppressive fires can be developed on the M31 range.

(3) Formulation and processing of hasty fire plans can be practiced.

d. Full-scale training, however, must take place to develop fully modern battlefield techniques. Following the training on the M31 range, units will be well prepared to get maximum benefit from combined arms training and live-fire exercises.

Section IV. TRAINING — OUR NUMBER ONE MISSION

13-17. Effective Training

The importance of effective training cannot be overstated. Only when individual and unit proficiency are high can we hope to —

- Maximize our capabilities and minimize our vulnerabilities.

- Have confidence that we will win.

- Get the job done.

Preparing and conducting effective training is the peacetime leader's most difficult, but

most important, job. You must constantly strive to provide training that will challenge your soldiers both physically and mentally. To establish an effective training program you must remember that:

- TRAINING* is the key to *PROFESSIONALISM*.

- Training must be *PERFORMANCE-ORIENTED*.

- TRAINING MANAGERS* develop the training program.

- *TRAINERS* prepare, conduct, and evaluate training.

- The ARTEP is the *MASTER TRAINING PROGRAM*.

- Unit proficiency begins with individual proficiency.

- Valuable training materials are available through the Field Artillery School.

- Imaginative use of time, ammunition, personnel, and equipment is essential.

- Training must be realistic — *TRAIN AS A COMBINED ARMS TEAM*.

13-18. Combined Arms Training

a. *WE MUST TRAIN THE WAY WE ARE TO FIGHT*. The requirement for *REALISTIC TRAINING* means that the field artillery battery and battalion must train *AS MEMBERS OF THE COMBINED ARMS TEAM*. The field artillery *cannot* train in isolation. Fire support and maneuver training must be tied together in a real world environment.

- When maneuver *companies* train, the field artillery forward observers must be with them.

- When maneuver *battalions* train, the fire support officers must be with them.

- When maneuver *brigades* train, field artillery battalions must be with them.

- When the *division* trains, the division artillery must be there.

Combined arms training is not always easy to accomplish. Therefore, always be on the lookout for ways to combine field artillery and maneuver training.

b. Forward observers, fire support officers, and field artillery commanders at all levels must be completely in tune with the maneuver commander. All field artillery commanders must learn, through joint training, to "see" the battlefield through the eyes of the maneuver commander. Concurrently, the maneuver commander must learn field artillery capabilities in order to better plan and use available fire power.

c. Our primary objective is to develop a well-trained combined arms team capable of integrating maneuver and fire power. *NO MISSION IS MORE IMPORTANT THAN THIS*.

Train for Combat
**You only get good at
what you practice.**

APPENDIX A REFERENCES

A-1. Publication Indexes

Department of the Army Pamphlets of the 310-series should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to material covered in this manual.

A-2. Army Regulations (AR)

- | | |
|--------|--|
| 310-25 | Dictionary of United States Army Terms |
| 310-50 | Authorized Abbreviations and Brevity Codes |

A-3. Department of Army Pamphlets (DA Pam)

- | | |
|------------|--------------------------------------|
| 310-series | Index of Military Publications |
| 310-15 | Forms Management and Standardization |

A-4. Field Manuals (FM)

- | | |
|------|--|
| 6-2 | Field Artillery Survey |
| 6-20 | Fire Support for Combined Arms Operations |
| 6-40 | Field Artillery Cannon Gunnery |
| 6-50 | The Field Artillery Cannon Battery |
| 21-6 | How to Prepare and Conduct Military Training |

A-5. Firing Tables (FT)

- | | |
|-------------|--|
| 14.5-A-1 | Cannon, 14.5mm, M31 Artillery Trainer Firing Fuzed Cartridges, M181, M182, M183 |
| 155-ADD-I-1 | Firing Table Addendum to FT 155-AM-1 for Projectile, HE, M449A1 (M449E2), Projectile, HE, M449 (T379), Projectile, HE, M449E1, |

155-AJ-2

Firing Tables for Cannon, 155mm, Howitzer, M126E1 and M126 on Howitzer, Medium, Self-Propelled, 155mm, M109 and Cannon, 155mm Howitzer, M185 on Howitzer, Medium, Self-Propelled, 155mm, M109A1 Firing Projectile, Atomic, M454

155-AM-1

Firing Tables for Cannon, 155mm Howitzer, M185 on Howitzer, Medium, Self-Propelled, 155mm, M109A1 and Howitzer, Medium, Self-Propelled, 155mm, M109A1B

A-6. Training Circulars (TC)

- | | |
|--------|--|
| 6-40-3 | M31 Field Artillery Trainer |
| 21-5-3 | TEC Management Instruction |
| 21-5-4 | Catalog of Training Extension Course Lessons |

A-7. DA Forms (Available through normal AG Publications Supply channels)

- | | |
|------|--|
| 4504 | Record of Fire |
| 4505 | 155mm Nuclear Computation — MET Correction Technique |
| 4506 | FDC Template (1:25000) |

A-8. Miscellaneous Publications

- | | |
|-------------|--|
| ARTEP 6-105 | Field Artillery 105mm Howitzer, Towed, Infantry, Airmobile, and Airborne Divisions and Separate Brigades |
| ARTEP 6-165 | General Support Cannon Units |
| ARTEP 6-365 | Field Artillery, 155 SP, Direct Support Units |

TM 9-6920-
361-13 & P

Operator, Organizational,
and Direct Support Maintenance Manual, Trainer,
Field Artillery: 14.5mm,
M31 and Kits (to be published)

A-9. USAFAS Training Support Publications

Field Artillery Catalog of Instructional Material (available by writing CMTD, USAFAS, ATTN: ATSF-DT-FSEX, Fort Sill, OK 73503)

USAFAS Correspondence Course Catalog (available by writing CMTD, USAFAS, ATTN: ATSF-SE-R, Fort Sill, OK 73503)

APPENDIX B

DELIVERY ACCURACY

B-1. General

Considerable time is spent on research and development trying to produce weapon systems which will hit exactly where they are aimed every time they are fired. Some weapon systems have been refined to come close to this goal; others, because of the physical and operational conditions under which they must be used, are not likely to be that accurate. Cannon artillery systems fall into this latter category.

B-2. Delivery Accuracy

Delivery accuracy is a measure of the ability of a weapon system to place munitions on an aiming point. Inaccuracy of a weapon system is caused by a number of factors including hardware inaccuracies, environmental effects, and human error. The two basic types of errors associated with weapon system accuracy are:

- a. *Precision (dispersion) errors.*
- b. *MPI (aiming) errors.*

B-3. Precision Errors

a. Dispersion is the scatter of burst points about the mean point of impact of a group of rounds fired at the same data from a *SINGLE* weapon on a single occasion from a *SINGLE* site (fig B-1).

b. The precision error is a round-to-round variation which is caused in part by:

(1) Conditions in the bore. Variations in the bourrelet and rotating band may cause

inaccurate centering of the projectile and, hence, inaccurate flight. Muzzle velocity is affected by:

(a) Minor variations in weight, moisture content, and temperature of the propelling charge.

(b) Variations in the arrangement of the powder grains.

(c) Differences in the ignition of the charges.

(d) Minor differences in the weights of the projectiles and the shapes of the rotating bands.

(e) Variations in the temperature of the bore from round to round.

(2) Conditions in the carriage. Direction and elevation are affected by play (looseness) in the mechanisms of the carriage, by physical limitations on precision in setting scales, and by nonuniform reaction to firing stresses.

(3) Conditions during flight. Air resistance is affected by differences in weight, velocity, and form of the projectile and by changes in the wind and in the density and temperature of the air from round to round.

c. The precision (round-to-round) error associated with a weapon/ammunition combination is most often expressed in terms of probable errors (PE's). The most concise definition of probable error is that it is an error which is exceeded as often as it is not. To the

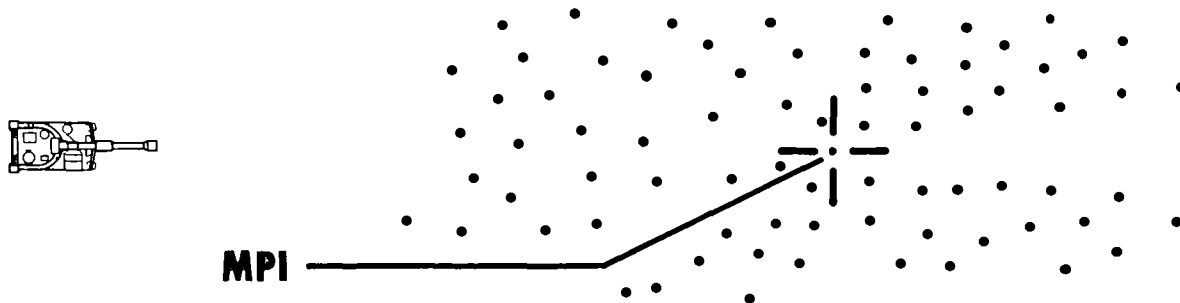


Figure B-1. Precision error (dispersion).

field artillery, "probable error" means "precision probable error", the measure of round-to-round variation, and nothing else. The probable errors found in tabular firing tables are *PRECISION* probable errors.

d. Because we do have precision errors all rounds fired at the same data (single weapon, single occasion) will not fall at a single point but will be scattered in a pattern of bursts. The related probable errors indicate the expected size of this pattern. For the most part, the precision errors associated with cannon artillery make it more suitable for use as an area weapon rather than as a killer of hard, point targets.

Note. The Cannon Launched Guided Projectile, a terminally-guided munition, will in the future give the field artillery a real single-shot kill capability against moving and stationary armored targets.

B-4. MPI (Aiming Error)

a. Given no aiming error, the rounds fired from a single weapon would form a pattern centered on the target. Often, however, it is impossible to aim a weapon perfectly because of influences such as weather and human proficiency. This type of error, the MPI error, causes the center of the pattern to be offset from the target.

b. The MPI error is defined as the scatter of MPI's about an aimpoint. The aimpoint is not

necessarily the target; there may be an unknown target location error. The MPI error is an occasion-to-occasion error (fig B-2).

c. Precision errors are caused primarily by inherent errors in a single weapon and ammunition system. MPI errors are caused by system errors such as imperfect aiming procedures and erroneous meteorological data. In an observer adjusted fire mission the primary source of MPI error will be the observer's adjustment inaccuracies. In the MET + VE predicted fire mission the MPI error will be caused by:

(1) Met errors. Variations in range wind, cross wind, temperature, and density due to:

(a) Measurement errors.

(b) Staleness (age) of the met.

(c) The difference in the weather conditions at the met station and those at the firing unit.

MET ERRORS ARE NORMALLY THE LARGEST CONTRIBUTORS TO MPI ERROR.

(2) Velocity errors.

(3) Registration errors. A registration is never completely accurate, but it is assumed to be so; therefore, there is a residual error associated with each registration.

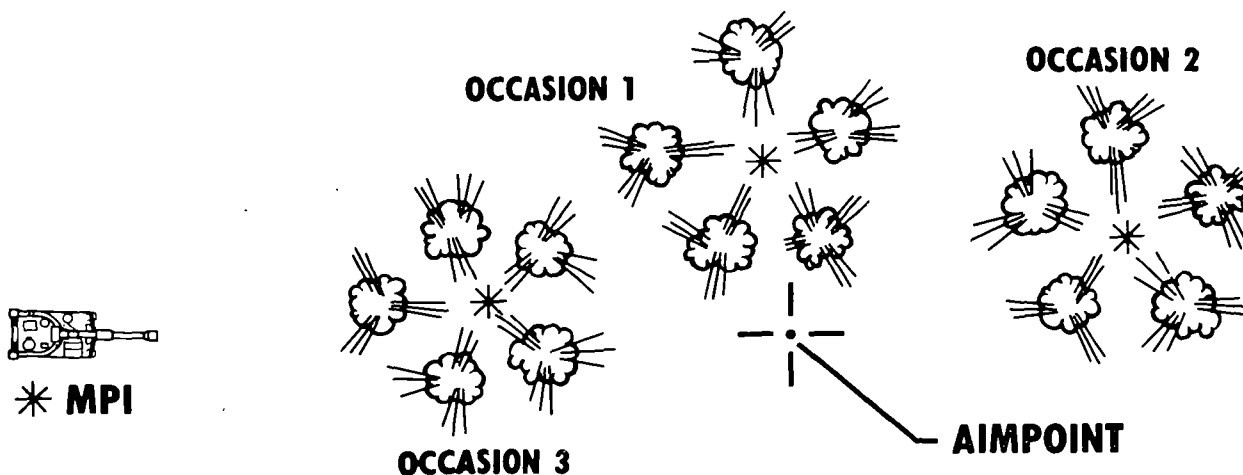


Figure B-2. MPI error.

B-5. Accuracy Estimates

a. The delivery accuracy estimates for the M109A1 155mm howitzer firing MET + VE missions are presented in figure B-3 (see figures B-4 through B-7 for other systems). This figure describes the CEP for total system error (precision and MPI) as a function of range. The Circular Error Probable or CEP is defined as the radius of a circle, centered at the aimpoint, within which 50 percent of the rounds are expected to impact. The CEP is an average value of what accuracy can be expected of a weapon. For example, firing an M109A1 155mm howitzer at range 10,000 meters, charge 7, using the MET + VE delivery technique, we can expect to be within 87 meters (radial) of our aimpoint 50% of the time.

b. Considerations applicable to the data presented in the figures include:

(1) The estimates do not include target location and survey errors.

(2) The met errors are based on a met message that is four hours old and taken at approximately fifteen kilometers from the weapon position.

(3) Although these estimates are for MET + VE missions, they are applicable to the first rounds fired in observer adjusted missions.

(4) Although low charges are designed for short-range operations, the low-charge error is often double that of the highest charge that you can fire at the same range. A

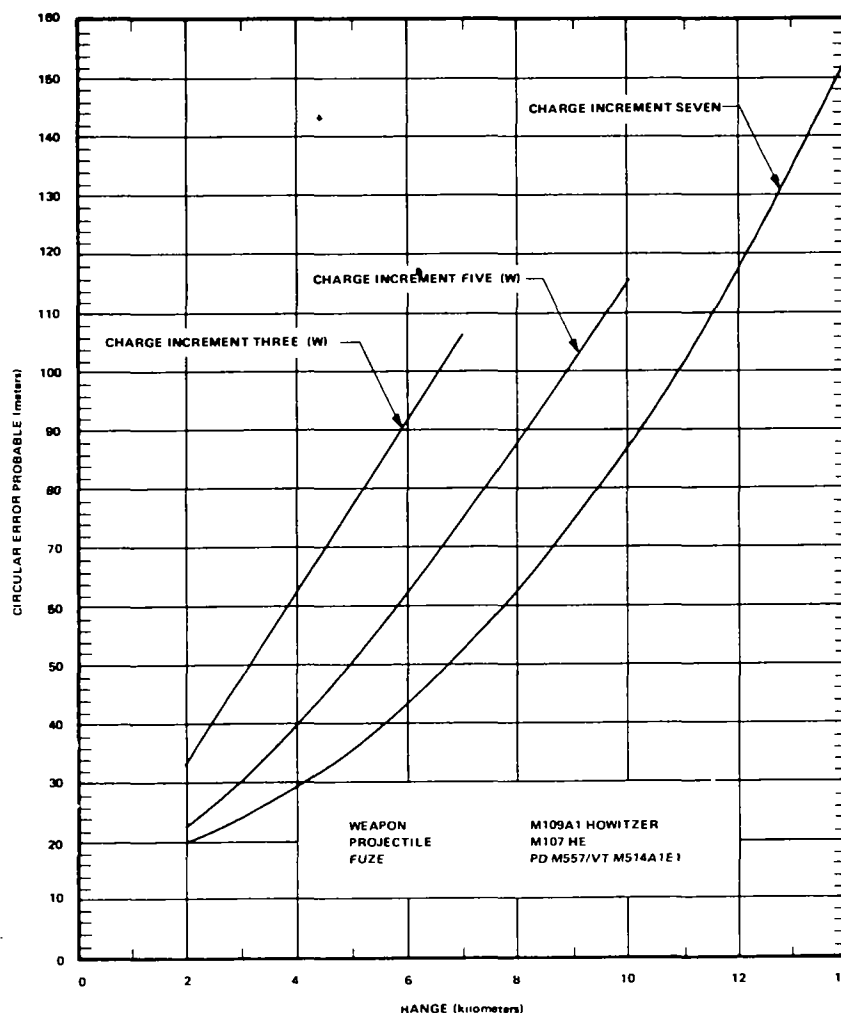


Figure B-3. M109A1 MET + VE delivery accuracy.

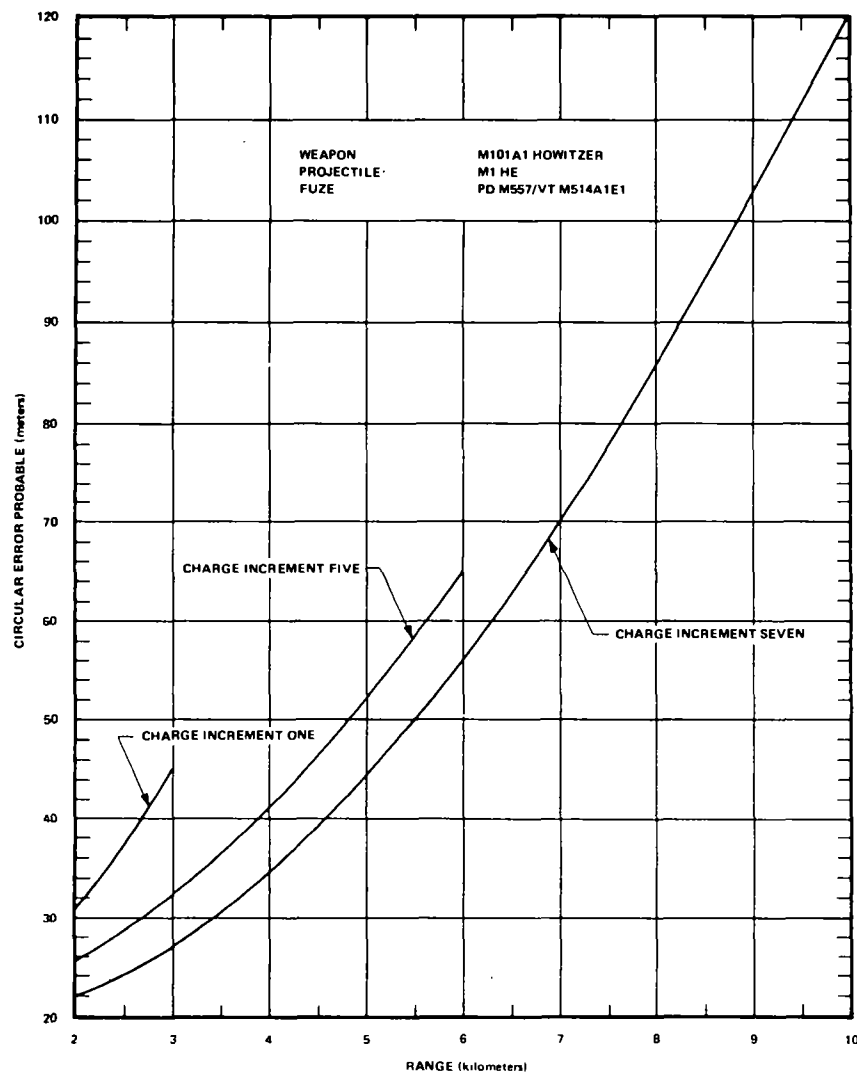


Figure B-4. M101A1 (also applicable to M102 howitzers) MET + VE delivery accuracy.

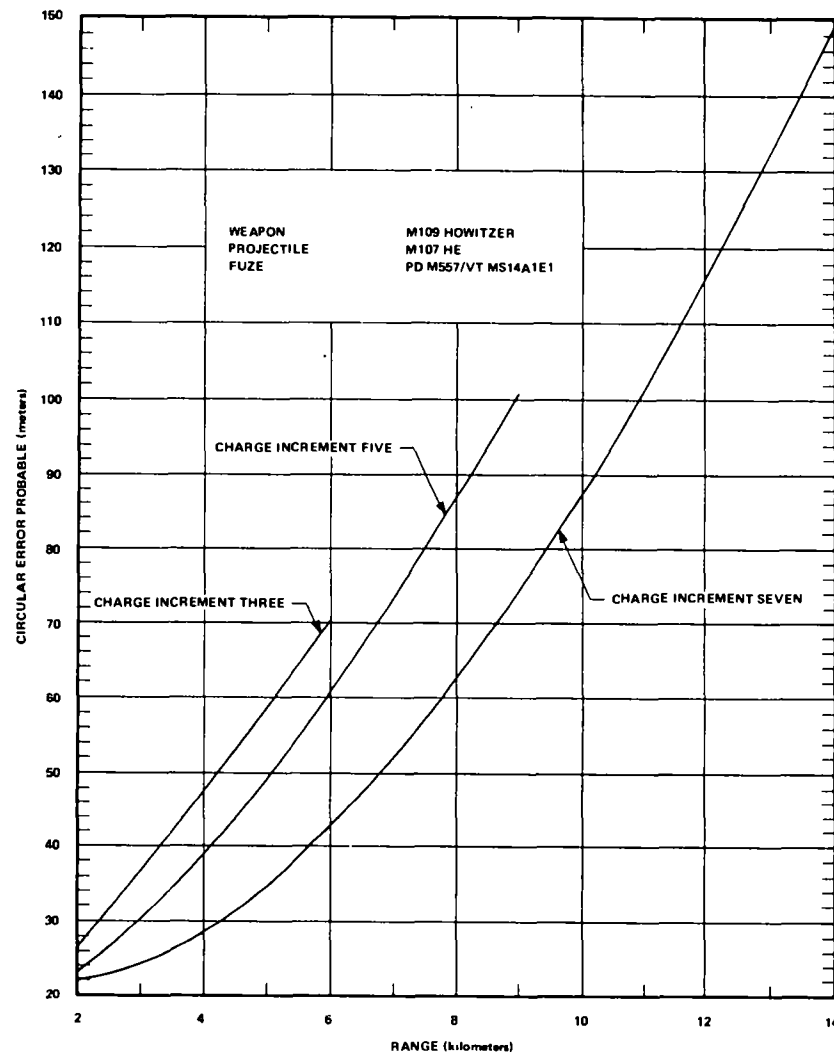


Figure B-5. M109 MET + VE delivery accuracy.

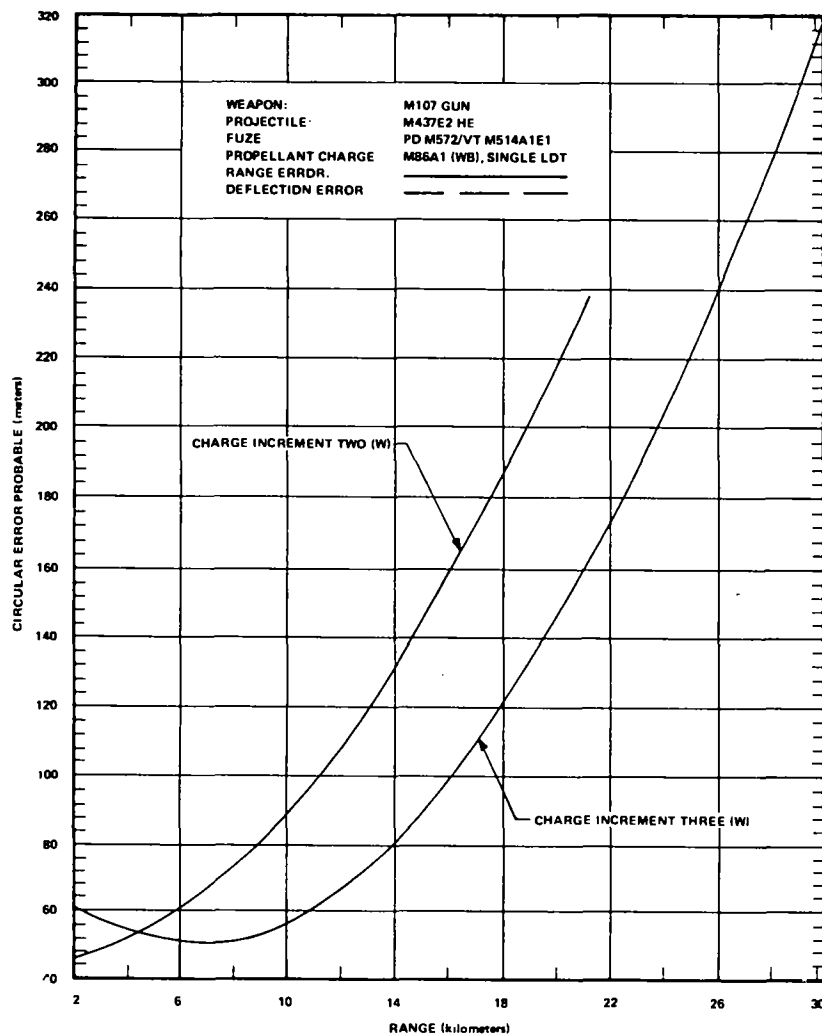


Figure B-6. M107 MET + VE delivery accuracy.

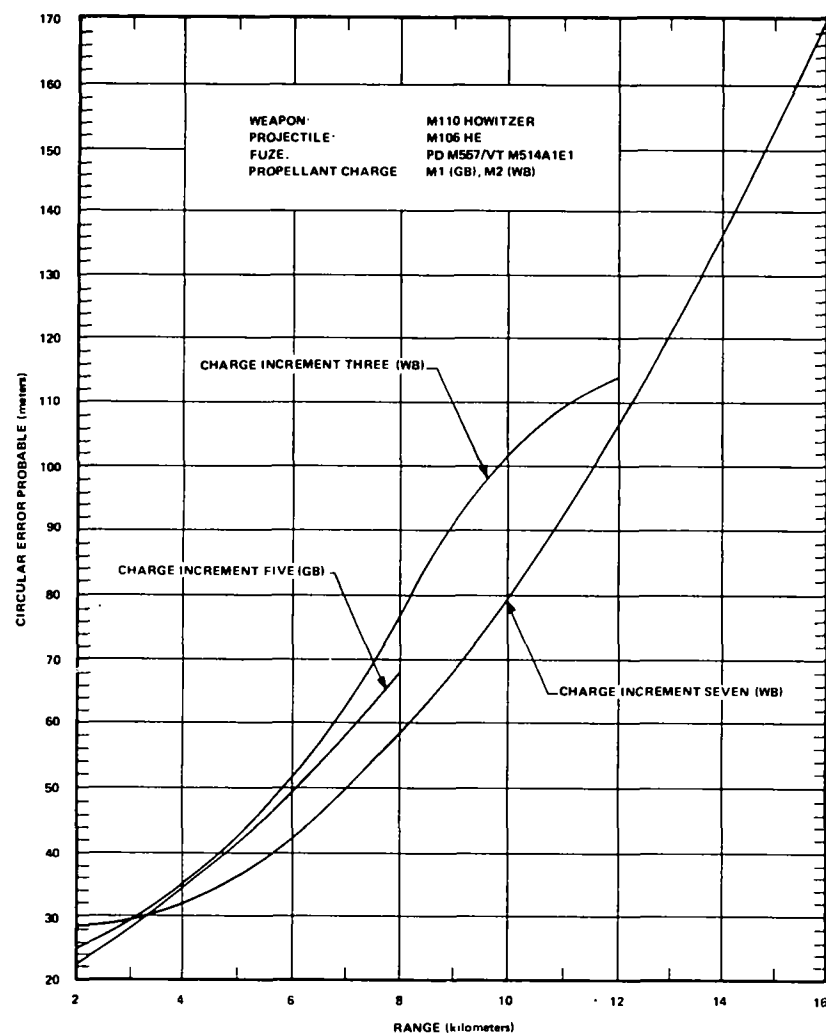


Figure B-7. M110 MET + VE delivery accuracy.

major cause of this is projectile instability due to slower launch (muzzle) velocities.

B-6. Delivery Accuracy Considerations

Delivery accuracy must be a consideration in determining how a weapon system is to be employed. Generally, it can be said that:

a. Accuracy is better at shorter ranges. The closer the weapon is to the target the more accurate the fire. This is particularly true for the MET + VE technique (or first round of observer adjust mission).

b. For a given range, you improve *DELIVERY ACCURACY* by firing the *HIGHEST PRACTICAL CHARGE*.

c. Field artillery weapons are area weapons rather than point-target killers.

d. Practical shortcuts designed to increase responsiveness can be made without sacrificing a significant degree of accuracy. The current field artillery system is simply not accurate enough to justify using time-consuming, super-precise procedures against every target.

APPENDIX C

ORGANIZATION OF THE FDC

C-1. General

The physical arrangement of the FDC has a significant effect on the efficient processing of a fire mission. Therefore, the arrangement of each FDC must be critically examined to insure that it helps rather than hinders the efforts of FDC personnel to provide timely and accurate fire. The basic concept of a good physical arrangement of the FDC requires, first, that it allows the FDO to observe the work of all personnel; second, that it allows the fire mission to be processed with a minimum of communication and movement; and third, that it provides all personnel with ready access to the equipment and data necessary to perform their tasks. To satisfy these requirements, the working area of the FDC must be restricted in size, but large enough to allow the necessary freedom of movement. Additionally, each job should be established as a functional unit; that is, all the required equipment must be available and all information needed must be clearly displayed or tabulated for immediate use.

C-2. Operational Tips

- a.* Write a field SOP defining specific personnel duties and providing individual checklists.
- b.* Provide for efficient division of duties.
- c.* Require adherence to standard techniques and procedures.
- d.* Streamline fire order and fire commands.
- e.* Follow maneuver progress; anticipate needs.
- f.* Have battalion determine FADAC-derived GFT settings for batteries not equipped with FADAC.
- g.* In mobile situations, have M577A1-equipped battery FDC's operate totally from within the carrier (i.e., without tent extension) to reduce the time required to set up/displace.
- h.* Organize and train for 24-hour and

split operations.

- i.* Keep non-essential personnel/equipment out of the FDC.
- j.* Position the FDO to allow his supervision of all members of the FDC.
- k.* Use charts that are visible to all for recording various data; e.g., fire order and fire command standards.
- l.* Keep mission essential data (registration corrections, MV's, ammo status, etc.) current.
- m.* Provide for appropriate checks and backup capability. With a properly functioning FADAC there is no need for two fully operational firing charts to be set up.
- n.* Process missions with as little communication or movement as necessary.
- o.* Color code the VCO map to facilitate determination of target altitude and computation of site.

C-3. Equipment tips

- a.* "Build-in" as much equipment as possible; attempt to reduce the amount of equipment which must be moved or set up (broken down) before the FDC is ready for action (prepared to move).
- b.* Place the FADAC on a swivel mount which allows the operator to work inside the carrier or from the lowered ramp (when the tent extension is being used).
- c.* Mount the firing chart(s) on a slant; this saves horizontal space (inside the carrier) and is less tiring for the operator.
- d.* Provide for rapid emplacement of the generators; a "generator trailer" can be "dropped" and the carrier moved far enough away to reduce the effect of generator noise.
- e.* Prewire and secure into position radic and wire gear to facilitate establishment of communications with other sections/units.
- f.* Insure often used equipment is stored in an easily accessible location while little

used gear is placed out of the way.

g. Wire the carrier for adequate lighting of respective work areas.

h. Properly maintain all equipment or it will fail you when you need it most.

i. Through local authorization, obtain a hand-held calculator to speed manual computations; e.g., manual solution of registration corrections from a high-burst registration.

C-4. Arrangement tips

a. Organize so that FDC personnel and equipment restrict movement as little as possible.

b. Establish a communication system that allows all personnel to hear the call for fire.

c. Position personnel who pass information to one another so that they are facing each other; e.g., chart operator and computer.

d. Whenever possible, set the FADAC to allow the computer to view FADAC outputs directly.

e. Set FADAC up on slight slant (rear of FADAC lowered) so that the FDO can also observe the display.

f. Locate all forms, data, and equipment so they are readily available to appropriate FDC personnel.

g. When determining work areas, consider whether personnel are right or left-handed.

APPENDIX D

NEW DEVELOPMENTS

D-1. Improvements in the System

The next several years will bring about remarkable improvements in the field artillery system. With the new equipment that is programed in these time frames, the artillery will improve its overall responsiveness, flexibility and survivability. It is not a sure thing that each item discussed will be fielded; however, this type of equipment is highly desirable.

sion fire support element. TACFIRE will increase the effectiveness of fire support through greater accuracy, faster and better use of target information, and more efficient allocation of fires. The FDC will benefit from the automation of the following functions: fire unit and ammunition status, meteorological data, nonnuclear fire planning, target intelligence, tactical and technical fire direction, and survey information.

IMPROVEMENTS IN THE FIELD ARTILLERY SYSTEM

AREA	PRESENT	NEAR TIME FRAME	MID TIME FRAME	IMPROVEMENT
Computer	FADAC	TACFIRE/Battery Computer System		Speed, increased capabilities
Survey	Survey Team	PADS		Speed; immediate availability; improved predicted fire
Met	Rawinsonde		FAMAS	Automatic entry of timely, accurate met into TACFIRE
Muzzle Velocity	Chronograph Registration VE	Velocimeter		Real time muzzle velocities; reduced registration requirements
FO	FO with Map	Laser Rangefinder	FO Vehicle	Rapid, accurate, secure target location, automated fire control loop; increased FO survivability
Ammunition	HE; ICM	Scatterable Mines		Capability to emplace minefields faster
			CLGP	Single shot kill capability against armor
			Random Delay ICM	Lengthy suppression with minimal firing
Firing Battery	Aiming Circle		Firing Battery Alignment and Positioning System	Near instantaneous laying; will allow weapons to disperse to hide in nonfiring positions
Countermortar/Battery Radar	AN/MPQ-4A		AN/TPQ-36	Increased capabilities
			AN/TPQ-37	Viable counterbattery acquisition capability, automatic entry of target data into TACFIRE

D-2. Near Time Frame Developments

Devices that should enter the inventory in the near time frame include:

a. Tactical fire direction system (TACFIRE). TACFIRE is designed to perform the same operations as those performed manually in the battalion and division artillery fire direction centers, as well as those in the divi-

b. Battery computer system (BCS). This unit will be a high speed replacement for FADAC which will interoperate with TACFIRE. The battery computer will have capabilities exceeding those of FADAC, including the ability to accept individual piece locations and automatically compute firing data for special sheafs. The FO will send data to the battery computer by his digital message

device and the computer will transmit digital individual piece data to the firing section display unit; message transmission time will be virtually eliminated.

c. *Position and azimuth determining system (PADS)*. PADS will greatly extend the capabilities of survey sections, making the old "1 KM/Hr" dictum for survey obsolete. It will be vehicle mounted and will provide the field artillery with a fast, all-weather capability.

d. *Velocimeter*. This small, lightweight device will provide real-time muzzle velocity to the firing unit. Since one item will be issued to each cannon firing battery, the velocimeter, coupled with the FAMAS and PADS, will go a long way toward eliminating the need for registration.

e. *Laser rangefinder (LRF)*. The AN/GVS-5 will provide the observer with a rapid, accurate distance to the target and a much improved capability for entering fire for effect with a one-round adjustment. Used in conjunction with the digital message device, the LRF will allow rapid and secure transmission of polar plot data.

f. *Scatterable mines (FASCAM)*. The field artillery will possess the capability to lay minefields by firing these projectiles. FASCAM can save the maneuver commander both time and manpower in the emplacement of minefields and provides another important suppression asset for use in enemy rear areas.

D-3. Mid Time Frame Developments

A little further down the line we can expect to see:

a. *Field artillery meteorological acquisition system (FAMAS)*. FAMAS will be a low-cost, lightweight, portable replacement for the GMD-1 met system. This system will be digitally linked to TACFIRE. The FAMAS will improve met data and save considerable time through automatic entry of the messages.

b. *Firing battery alignment and positioning system*. This system permits weapons to be laid almost instantaneously after halting in a firing position. This capability will permit weapons to disperse and to hide in nonfiring positions. The system would include a relatively low-cost navigational device for each firing unit. The battery could pick up accurate survey control from PADS and then extend this control to primary, alternate, and roving gun positions. PADS and a battery navigational device will not only speed up survey but often will provide survey that otherwise would not be available.

c. *Cannon-launched guided projectile (CLGP)*. The CLGP is a terminally-guided projectile which will give the field artillery a real single-shot kill capability against moving and stationary armored targets. Designation will be provided by an FO using a Ground Laser Locator Designator (GLLD).

d. *Random delay ICM*. This projectile distributes submunitions which will function at random intervals rather than at the time of impact. Random delay fuzing will allow the field artillery to suppress enemy elements for extended periods of time with a single firing.

e. *FO vehicle*. This vehicle will improve both the FO's survivability and efficiency on the modern battlefield. Desirable features include an integrated laser rangefinder, a position and direction-determining system, and an input/output device for a digital data link to TACFIRE/BCS.

f. *Mortar locating radar (AN/TPQ-36)*. The AN/TPQ-36 is a replacement for the AN/MPQ-4A radar and will be employed by the direct support artillery battalion to provide countermortar surveillance and acquisition to the supported brigade.

g. *Artillery locating radar (AN/TPQ-37)*. The AN/TPQ-37 will provide a viable counterbattery surveillance and acquisition capability. Target locations and information will be provided directly to TACFIRE via a digital interface.

APPENDIX E

HASTY TRAVERSE TECHNIQUE WITH THE M12 SERIES SIGHT

E-1. General

The hasty traverse procedures discussed in Chapter 10 require some modification when used with the M12 series sight. The M100 series sight has a deflection scale from 0-6400. The M12 series sight, on the other hand, has a deflection scale 0-3200, 0-3200. So a deflection read to an M12 series sight can fall on either 0-3200 scale and represent two different directions depending on whether the piece is to the left or right of the AC (see fig E-1).

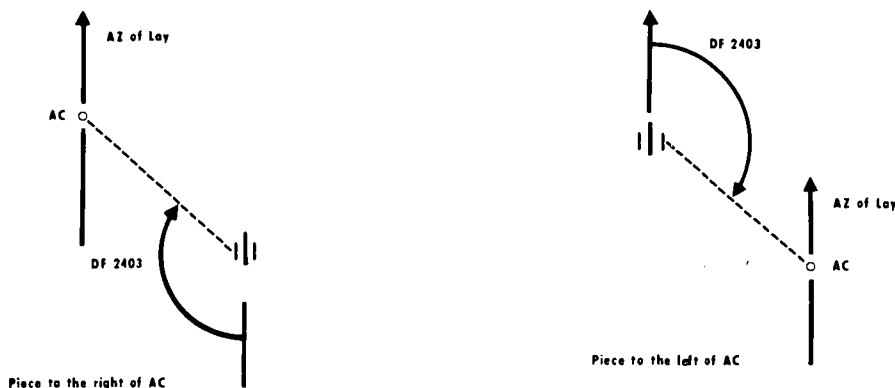


Figure E-1. Deflection with the M12 series sight.

E-2. Piece to the Right of the AC (with Respect to the Azimuth of Lay)

The hasty traverse technique for pieces to the right of the AC (with respect to the azimuth of lay) is the same as for weapons with M100 series sights. This is so because, in this

direction from the AC to the piece, you rotate the disk until the LAY DF + 3200 (rather than LAY DF) is over the index. To orient the board in the direction from base piece to the AC, you rotate the disk until the LAY DF (rather than LAY DF + 3200) is over the index.

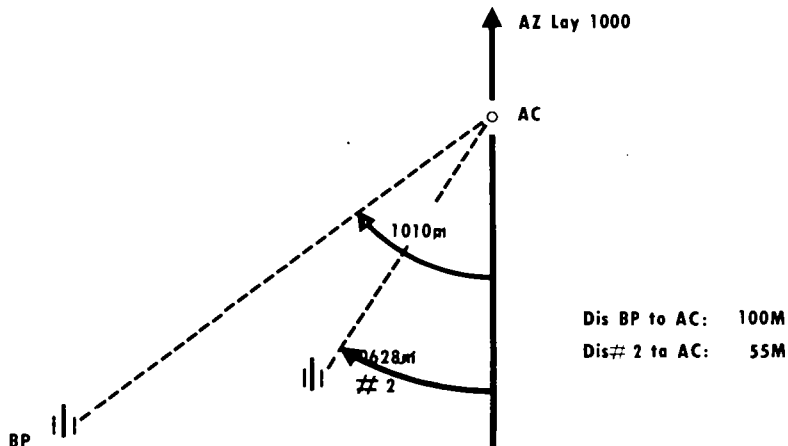


Figure E-2. Sample problem.

USE THE OUTER (BLACK) SCALE.

E-4. Example (Piece to the Left of the AC)

a. *Given:* Figure E-2.

b. *Required:* Plot the location of the AC and piece #2 on the plotting board.

c. *Solution:*

(1) Step 1. Construct the TGPC index. Rotate the transparent disk until 1000 (azimuth of lay) in the outer (black) numbers is over the red arrow. Place the TGPC index opposite the (black) zero on the outer scale.

(2) Step 2. Orient the plotting board in the direction from BP to the AC. Rotate the disk until 1010 (LAY DF as in para E-3 above) is over the TGPC index (fig E-3).

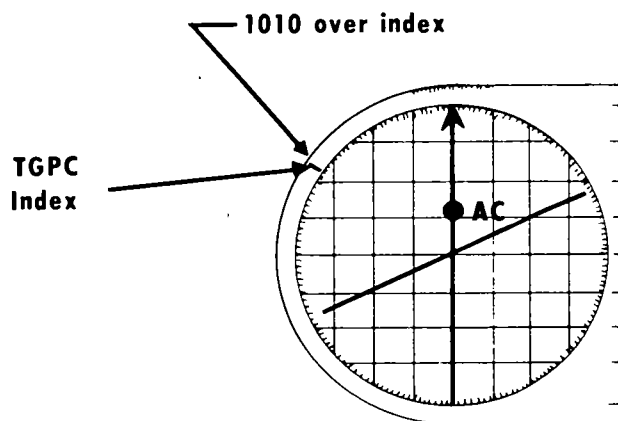


Figure E-3. Direction from BP to AC.

(3) Step 3. Plot the AC. Mark off 100 meters from the center of the board along the appropriate azimuth (red arrow). Place a dot and label it AC. This represents the location of the aiming circle.

(4) Step 4. Orient the board in the direction from the AC to piece 2. Rotate the disk until 3828 (0628 + 3200) is over the TGPC index (fig E-4).

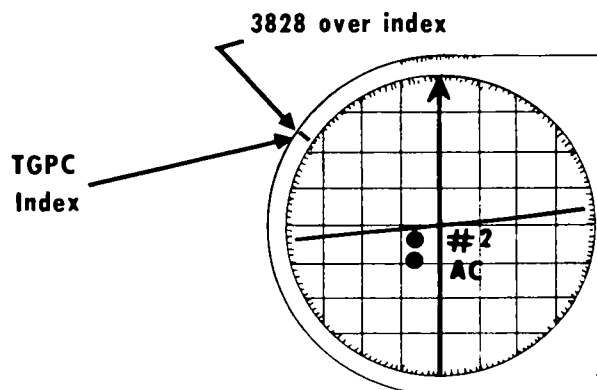


Figure E-4. Direction AC to piece 2.

(5) Step 5. Plot piece 2. Mark off 55 meters from the AC in the appropriate direction (parallel to and in the direction of the arrow). Place a dot and label it 2. This represents the location of piece 2.

(6) Step 6. Orient the board along the azimuth of lay (1000). Determine displacement of piece 2 with respect to the azimuth of lay: 50R, 15F.

APPENDIX F

SPECIAL SMOKE MISSIONS

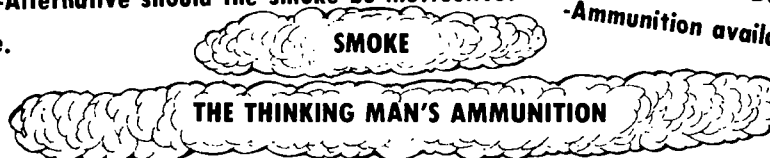
F-1. General

When dedicated smoke assets are available and the exact positioning of individual smoke rounds is of prime importance, special corrections can be computed for each gun. This is *THE LEAST RESPONSIVE TYPE OF SMOKE TECHNIQUE*, however, and should be considered only when the size of the screen and the weather make employment of quick smoke impossible.

F-2. The Observer

a. *Employment considerations.* Prior to firing a special smoke mission, take the following factors into consideration:

- Weather conditions.
- Approval of the maneuver battalion or brigade commander.
- Means available.
- Alternative should the smoke be ineffective.
- Time to be effective.
- Location of the area to be screened.
- Duration required.
- Ammunition available.



b. *Planning requirements.* In order to plan for the special smoke mission, determine:

- (1) The size of the screen.
- (2) The attitude of the screen.

c. *The call for fire.* The call for fire should include the additional elements listed in Table F-1. (If the data for these elements are not available, sending the call for fire must not be delayed. The additional elements are sent as the data become available.)

Table F-1. Additional elements for special smoke.

ELEMENT	ACCURACY
Linear length (the length of the line of effective smoke required).	Nearest 50 meters
Attitude (the azimuth of the line of canisters from the adjusted point).	Nearest 100 mils.
Wind direction in relation to the line of effective smoke.	Cross, quartering, head/tail.
Wind speed.	Nearest 5 knots.
Smoke condition.	Ideal, Favorable, Marginal.
Length of time the smoke is required.	Nearest minute.

H53 THIS IS H59,
ADJUST FIRE, SHIFT 177,
OVER.

DIRECTION 3400,
LEFT 200,
ADD 100, OVER.

LENGTH 1200, ATTITUDE 5400,
FAVORABLE, QUARTERING WIND,
10 KNOTS, DURATION 20
MINUTES, HC IN
EFFECT, OVER.

d. *Placement of the smoke.*

(1) The observer selects the HE adjusting point at one end of the screen (normally the upwind end) and moves the adjusting point 100 meters upwind (200-400 meters for a tailwind). For special smoke do not use the maneuver-target line in determining wind direction; the wind direction is based on the attitude of the line of effective smoke (taking into consideration the location of the enemy).

(2) In coordination with the maneuver commander, determine the location and attitude of the screen.

(3) If the tactical situation permits, it is desirable to fire a test smoke round (tester) at the upwind adjusting point following the HE adjustment to insure that the FFE rounds will be effective. Final refinement can be given after the tester has been fired. Permission to fire the tester must be obtained from the maneuver element commander.

e. *Fire for effect.* Once the smoke rounds have been fired, insure that holes or gaps are

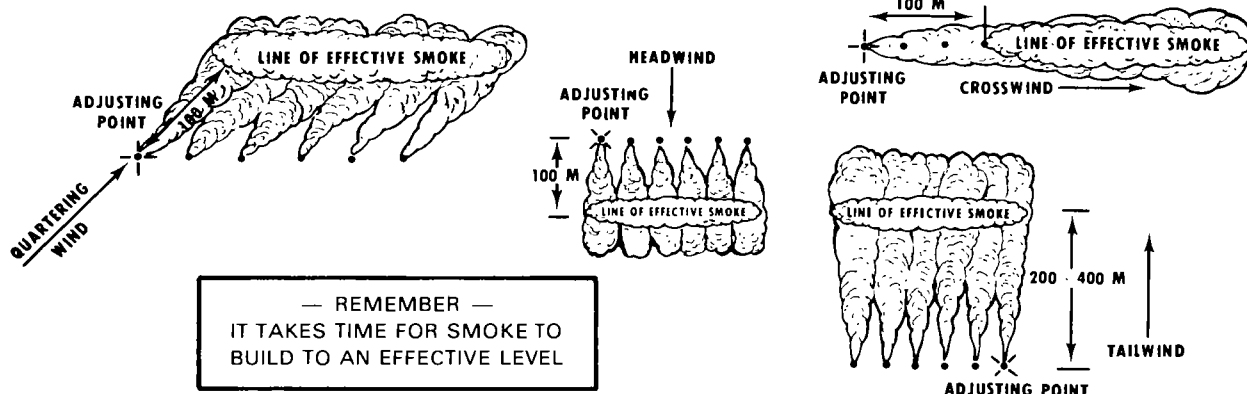
Delivery Technique	Wind Direction				Adjusting Point With Respect to:
	Cross	Quartering	Head	Tail	
Individual rounds	100UW	100UW	100UW	200 to 400UW	Upwind end of the line of effective smoke

S-Short

UW-Upwind

Data in meters

105mm and 155mm howitzer



filled and that the smoke lasts until the maneuver unit has crossed to the pre-arranged position. In order to fill holes or gaps, either change the rate of fire for a given point or adjust the location of the point. The message to observer will include the number of guns to fire. Points are numbered in sequence progressively along the line of smoke, starting at point number 1 (the adjusting point).

F-3. The FDC

a. *Considerations.* A SPECIAL SMOKE MISSION REQUIRES CONSIDERABLY MORE PLANNING TIME BY BOTH THE FO AND THE FDC THAN AN IMMEDIATE OR QUICK SMOKE MISSION, AND NORMALLY REQUIRES LARGE EXPENDITURES OF AMMUNITION.



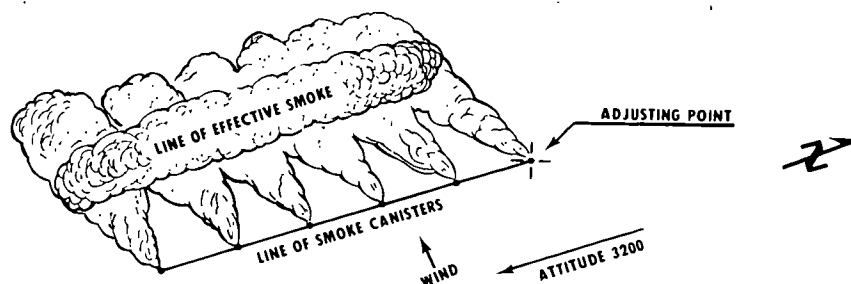
c. *Initial computation (MANUAL and FADAC).*

DELIVERY TECHNIQUE	TYPE OF TGT	NO OF GUNS	TYPE OF AMMO	SHEAF	OBSCURATION TIME	COMMAND AND CONTROL
Individual rounds	Deliberate Screen 400-2400M	2-6 Guns	HC	Special corrections	Length determined by maneuver commander	Maneuver battalion or brigade commander in coordination with adjacent units

b. *Computations.* In order to compute the firing data, the FDC must have received the following data from the FO or FSO:

- (1) Location of the adjusting point.
- (2) Length of the line of smoke.

(1) Adjust the HE onto the adjusting point with the base piece. The adjusting point is located at the beginning of the line on which the smoke canisters are to be placed when facing in the direction of the attitude given by the observer.



(2) While the adjustment is in progress, determine the number of guns to fire, the distance between impact points, the time length of replenishment, the rate of fire, and the total number of rounds to be fired per gun. The following example illustrates the sequence of initial computations.

EXAMPLE

Known data

--155mm howitzer battery.

--Fuze quick is standard.

--Base piece is the standard adjusting piece.

CALL FOR FIRE

H53 THIS IS H59,
ADJUST FIRE, POLAR,
OVER.

DIRECTION 800,
DISTANCE 3000,
OVER.

LENGTH 1400, ATTITUDE 3200,
FAVORABLE, QUARTERING WIND,
10 KNOTS, DURATION 10 MINUTES,
HC IN EFFECT, TOT 0914, OVER.

(a) Determine the *NUMBER OF GUNS* to fire.

--Enter the table of factors for determining effective obscuration length. Extract a factor of 0.40.

--Multiply the factor obtained by the length of the screen in hundreds of meters and express the product to the next higher whole number. The expressed product is the number of guns required to provide the requested screen.

$$\text{NUMBER OF GUNS} = \text{FACTOR} \times \text{SCREEN LENGTH} \div 100$$

$$14 \text{ (length in hundreds of meters)} \times 0.40 = 5.6 \approx 6 \text{ guns.}$$

Table of Factors

WIND DIRECTION	105mm		155mm	
	HC	WP	HC	WP
Cross	0.40	1.30	0.29	1.00
Quartering	0.57	1.67	0.40	1.30
Head or Tail	2.00	2.00	1.30	2.00

(b) Determine the *DISTANCE BETWEEN THE IMPACT POINTS* by dividing the length of the line of effective smoke by the number of guns. Expressing the quotient to the nearest 50 meters. $1400 \div 6 \text{ guns} = 233.3 \approx 250 \text{ meters.}$

(c) Determine the *TOTAL TIME* length during which smoke is *TO BE REPLENISHED*.

Length of time smoke required. 10 minutes

Time to build to effective level.
(Table F-2) (+) 1 minute

Duration of smoke. 11 minutes

Average burning time.
(Table F-2) (-) 4 minutes

Total time during which smoke is to be replenished. 7 minutes

(d) Determine the *RATE OF FIRE* by entering table F-3 and extracting the value of 1 round per minute.

(e) Determine the *TOTAL NUMBER OF ROUNDS PER GUN*.

--Calculate the number of rounds per gun required to maintain the screen by multiplying the rate of fire by the time length for replenishment; express the product to the next higher whole number ($1 \times 7 = 7$ rounds per gun).

--Add the number of rounds per gun to establish the smokescreen to the number of rounds per gun to sustain the smokescreen ($1 + 7 = 8$ rounds per gun). The guns may be notified administratively of the number of HC rounds to be fired after this computation.

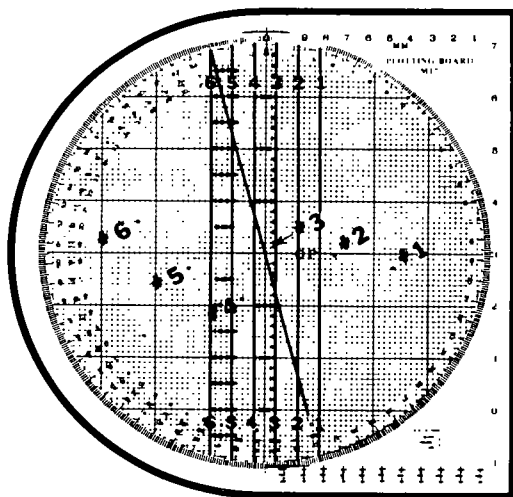
(3) The initial computation must be accomplished during the adjustment phase of the mission. As soon as the adjustment has been completed, send a message to observer stating the number of guns to fire.

H59 THIS IS H53, 6 GUNS, OVER.

d. Manual computations.

(1) Determine *POSITION CORRECTIONS* for each piece participating in the special smoke mission. Position correction calculations should begin as soon as the number of guns to fire has been determined. They should be computed concurrently with the calculations specified above.

(a) Use the M10/M17 plotting board upon which the individual piece locations have been placed. This should always be available in the FDC by SOP.



(b) Orient the plotting board disk to the azimuth of the initial adjusting point.

(c) Determine the displacement in meters of each gun from the battery center, which is now represented by the center of the disk.

(d) Record this data in columns ① and ⑨ of the Special Corrections for Terrain Gun Position section on the back of the Record of Fire (fig F-1).

NOTE. The position deflection correction required can be computed on a GST: Pos df

$$\text{corr (m)} = \frac{\text{lat corr (M)}}{\text{range}}$$

Table F-2. Smoke round effectiveness.

	105-mm		155-mm		4.2 in	81mm
	HC	WP	HC	WP	WP	WP
Buildup Time	1 min	½ min	1 min	½ min	½ min	½ min
Average Burning Time	3 min	1 min	4 min	1 min	1 min	1 min

Table F-3. Rate of fire.

SMOKE CONDITIONS	WIND SPEED IN KNOTS	ROUND PER MINUTE			
		105mm		155mm	
		HC	WP	HC	WP
Ideal	5	1	1½	½	½
Favorable	5	1	2	½	1
	10	2	4	1	2
	15	2½	6	1½	3
Marginal	5	3	*	1½	*

*Under these conditions the number of rounds exceeds the rate of fire for the weapon.

(e) Use columns ① through ⑤ for computing the position deflection correction in mils (the $100/R$ value in column ④ is determined at the initial adjusting point range).

(2) Use columns ⑥ through ⑩ for computing the total range corrections in meters. MV range corrections must be computed *ONLY* for those pieces with a battery comparative velocity error greater than plus or minus 1.5 meters per second (the muzzle velocity unit correction factors in ⑦ are determined at the initial adjusting point range).

WEAPON DATA

AZIMUTH OF LAY 6400m, DEFLECTION 3200m

PIECE DISPLACEMENT (M)
(FROM BATTERY CENTER)

PIECE	200 Right	100 Behind
#1	200 Right	100 Behind
#2	125 Right,	40 Behind
#3(BP)	0,	0
#4	55 Left	90 Behind
#5	140 Left	10 Forward
#6	200 Left	100 Forward

MUZZLE
VELOCITY
(M/S)

#1	316 5
#2	315 5
#3(BP)	314 7
#4	314 2
#5	313 5
#6	312 8

DEFLECTION 2929m, AZIMUTH 0271m

PIECE DISPLACEMENT (M)
(FROM BATTERY CENTER)

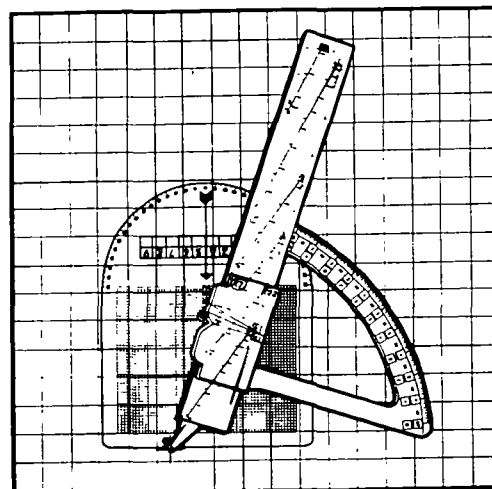
PIECE	220 Right,	45 Behind
#1	220 Right,	45 Behind
#2	130 Right,	5 Behind
#3(BP)	0,	0
#4	30 Left,	100 Behind
#5	140 Left,	30 Behind
#6	220 Left,	45 Forward

GFT: Chg		Lot		Rg		EI		Ti		DEFLECTION CORRECTION				
GFT <u>B</u>		Chg <u>4</u>		Lot <u>XZ</u>		Rg <u>5000</u>		EI <u>313</u>		Ti <u>18.4</u>				
FADAC RESIDUALS		Df ±		Fz ±		Rg K ±				Total GFT				
										L12 L5				
TRANSFER OF GFT SETTING														
Btry	①	②	③	④	⑤	⑥	⑦	NUMBER OF GUNS = 6 INTERVAL BETWEEN IMPACT POINTS = 250M TOTAL ROUNDS = 8 RATE OF FIRE = 1 ROUND/MINUTE CHART RANGE = 5630						
	Bn BP	MV Corr	MV Rg	Achieved	Corr Rg	EI ~ ⑤	Ti ~ ⑤							
	Comp	Factor	Corr	Rg		(Use EI)	(Use Ti)							
	VE	I-	① x ② =	③ + ④ =	(Gogeline)	(Gogeline)								
	M/S	M	10M	10M	10M	m	FS							
SPECIAL CORRECTIONS FOR TERRAIN GUN POSITION														
TRANSFER LIMITS														
L/R/R Sector Chg(s)														
Az (L) (R) Df (L) (R) Rg (Min) (Max)														
Gun	Corr To Burst Line	Dir Of Corr	Lateral Displ From BC (L/R)	Desired Lateral Displ From BC (L/R)	Lateral Corr Required (L/R)	100/R GFT	Pas Df Corr (L/R)	Btry Comp VE	MV Corr Factor (Table F)	MV Rg Corr	Pas Rg Corr	Total Rg Corr	Rg Change Per Mil Factor (Table F)	Pos EI Corr
#	#	T/A	M	M	M	m	m	M/S	M	M	M	M	M	m
1			220R	0	L220	18	L40	1.8	-23.6	-41	+45	+3	0	
2			130R	0	L130	18	L23				+5	0		
3														
4			30L	0	R30	18	R5				+100	+100		
5			140L	0	R140	18	R25				+30	+30		
6			220L	0	R220	18	R40	0.9	+30.4	+58	-45	+13	+10	

Figure F-1. Special smoke mission - reverse side of Record of Fire.

(3) Place the *FDC TEMPLATE ON THE FIRING CHART*. When the adjustment has been completed, remove the target grid, being careful not to lose the pin location, and replace the target grid for the hasty fire plan with an FDC template. Orient the template so that the arrow is pointing in the direction of the attitude of the line of canister impacts and the plotting pin is through the index point of the template in the adjusting point fire-for-effect pin location. Secure the template in that position and mark a small X at each canister impact point along the center line, which now represents the line of canister impacts (the X's may be marked on the center line any time after the distance between impact points has been determined). The number of points must be equal to the number of weapons to fire.

FOR SMALL SPECIAL SMOKE-SCREENS, A TARGET GRID MAY BE USED IN PLACE OF AND IN THE SAME MANNER AS THE FDC TEMPLATE.



(4) Determine the **FIRE-FOR-EFFECT CHART DATA**. Select and assign a gun to fire on each canister impact point; the adjusting piece will fire on point number 1 (adjusting point fire-for-effect pin location). **IT IS UNDERSTOOD THAT TRAJECTORIES MAY CROSS**. The chart operator must measure a range and a deflection to each canister impact point and announce this information to the computer. The chart range and chart deflection to each canister impact point should be recorded on a separate line in the **SUBSEQUENT FIRE COMMANDS** section on the front of the Record of Fire (fig F-2).

each gun to the chart range for the appropriate point. Use the corrected range to determine the fire-for-effect M564 fuze setting (minus 2 seconds) and elevation with GFT. Apply the site based on the initial chart range to the adjusting point to the elevation to obtain the FFE quadrant. Do not apply 20/R.

(b) Deflection. Algebraically apply the position deflection correction for each gun, the GFT deflection correction, and the drift (at the initial chart elevation) to the chart deflection for the appropriate point to obtain the fire-for-effect deflection.

RECORD OF FIRE																
Observer H59		CALL FOR FIRE (AF) FFE/IS/S		Tgt		QUARTERING, 10 KNOTS, DURATION 10 MINUTES, HC IN EFFECT, TOT 0914				△ FS						
Grid		Polor Dir 800		Dis 3000		U/D		VA ±		GFT L5		100/R				
Shift		Dir		L/R		+/-		U/D		DRIFT L8		/R				
LENGTH 1400		ATTITUDE 3200		FAVORABLE		→ Si -10		10m Si		HOB Corr		20/R				
FIRE ORDER SPECIAL CORRECTIONS, CHG 4, HC IN EFFECT										Df Corr L13		Si +3				
INITIAL FIRE COMMANDS		FM		MF BTRY ADJUST		Rg		Chf Df 2929		EI 367						
Sp Instr SPECIAL CORRECTIONS		Sh		Lot		Chg 4		Fz		T1		Df 2942		QE 370		
MTO BRAVO, 6 GUNS		→ T		PE _R		TF		HC		in Eff		Ammo Exp ①				
Tgt	Location	Priority	Firing Unit	SUBSEQUENT FIRE COMMANDS										AMMO		
Dir, MF Sh, Fz	Dev	Rg	HOB Corr	MF, Sh Chg, Fz	FS Corr	T1	Chort Df	Df Corr (L13)	Df Fired	Chort Rg	HOB Corr	Si (+3)	EI	QE	Exp	Type
	R100	+200					2960	L13	2973	5790		+3	381	384	(2)	HE/R
	L50	-100	FFE	#1 (PT #1)	-2.0	19.7	2945	L13	2958	5710		+3	374	377	8	HC
				#2 (PT #2)			2962	L13		5480						
								R40		+10						
				#5 (PT #3)	-2.0	18.7		R27	2935	5490		+3	354	357	8	HC
							2981	L13		5190						
								R25		+30						
				#4 (PT #4)	-2.0	17.4		R12	2969	5220		+3	334	337	8	HC
							2999	L13		4970						
								R5		+100						
				#2 (PT #5)	-2.0	16.7		L8	3007	6070		+3	319	322	8	HC
							2819	L13		4740						
								L23		0						
				#1 (PT #6)	-2.0	15.2		L36	2855	4740		+3	293	296	8	HC
							2842	L13		4530						
								L40		0						
							-2.0 (14.3)	L53	(2895)	4530		+3	276	(279)	8	HC
															(48)	HC
Btry B		DTG 121300 JUN 76		Tgt		Replot Grid		Replot Att								

DA FORM
1 MAY 76 4504

Replaces DA Form 3622, 1 Jan 74
and DA Form 4007, 1 Jan 73.

For use of this form, see FM 6-40 and FM 6-40-5. The proponent agency is US Army Training and Doctrine Command.

Figure F-2. Special smoke mission - FFE data.

(5) Compute the **HC FIRE-FOR-EFFECT DATA** for each gun. The computations for HC firing data should be recorded on the Record of Fire.

(a) Time and quadrant elevation. Apply the total position range correction for

(6) If a **SUBSEQUENT CORRECTION** is required for a specific canister impact point, place the target grid over the designated point (leaving the template in place), orient the target grid in the OT direction, plot the observer's correction, and determine new

chart data to this point. Apply the piece position corrections to the new chart data as previously outlined. If the entire screen must be moved, place the target grid over the fire-for-effect adjusting piece pin location (leaving the template in place). Orient the target grid in the OT direction, plot the observer's correction, and determine firing data to the pin location. Determine the differences in time, deflection, and quadrant elevation between this pin location and the original fire-for-effect location. Apply these differences to the firing data for the remaining guns.

e. FADAC computations. For accurate computations, the FDC must know the grid, altitude, and MV of each piece.

(1) Depress the appropriate battery selector button and conduct the *ADJUSTMENT WITH SHELL HE*.

(2) Upon completion of the adjustment, perform the following steps to compute the *HC FIRE-FOR-EFFECT FIRING DATA*:

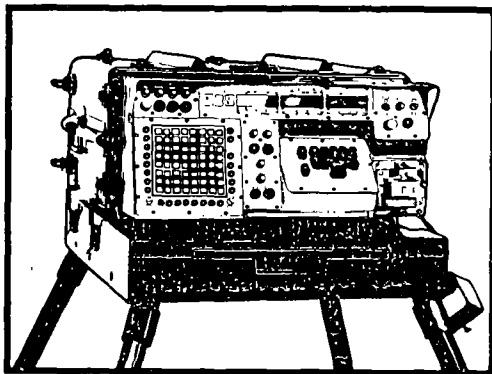
(a) Enter the projectile weight for smoke (HC) in G-3 (PROJ WT). (FADAC uses the weight for colored smoke as the standard.)

(b) Enter flag 3 for projectile smoke in B-5 (PROJ TYPE).

(c) Enter flag 2 for fuze for smoke round in B-6 (FUZE TYPE).

(d) Enter the azimuth representing the attitude of the line of canister impacts points in A-5 (OT DIR).

(e) Compute and record data for the adjusting piece (base piece) to fire on canister impact point number 1.



(f) Select and assign a gun to fire on each of the canister impact points. The assignment of a specific canister impact point to a specific gun is an arbitrary decision by the FDO (except for the assignment of the base piece to canister impact point number 1). It is understood that trajectories may cross.

(g) With the adjusting battery button still depressed, enter flag 5 in B-8 (MASS FIRE). This will transfer the target data to the E battery position.

(h) Depress battery selector button E. (If not previously entered, battery data should be entered (azimuth of lay, base deflection and powder temperature).)

(i) Enter the projectile weight for smoke (HC) in G-3 (PROJ WT).

(j) Enter the charge in B-1 (CHG).

(k) Enter flag 3 in B-5 (PROJ TYPE).

(l) Enter flag 2 in B-6 (FUZE TYPE).

(m) Enter the grid, altitude and MV of the gun to fire at canister impact point number 2 in H-1 (BTRY EAST), H-2 (BTRY NORTH), H-3 (BTRY ALT), and G-1 (MV).

(n) Enter (add) the distance between points along the line of canister impact points in A-7 (ADD/DROP).

(o) Compute and record the data for the gun to fire on canister impact point number 2.

(p) Repeat the preceding three steps for each remaining piece in the sequence of successive canister impact points. For example, the firing data to be computed next would be for the piece firing for effect on canister impact point number 3.

(3) If a *SUBSEQUENT CORRECTION* is entered to a specific canister impact point, all corrections that have been entered in matrix location A-7 (ADD/DROP) after data to that impact point were computed, must be subtracted before the new corrections are applied.

f. Execution.

(1) Upon receipt of the call for fire, the fire order will be issued and the initial fire

commands announced. Since the number of pieces to fire in effect is not known until after the completion of the initial computations, the entire battery must be alerted to follow the mission. After the number of pieces to fire in effect has been determined, give end of mission to all pieces not required.

FO's Call for Fire

H53 THIS IS H59,
ADJUST FIRE, POLAR,
OVER.

DIRECTION 800,
DISTANCE 3000,
OVER.

LENGTH 1400, ATTITUDE 3200,
FAVORABLE, QUARTERING WIND,
10 KNOTS, DURATION 10 MINUTES,
HC IN EFFECT, TOT 0914, OVER.

FDO's Fire Order

SPECIAL CORRECTIONS,
CHARGE 4, HC IN EFFECT.

Computer's Fire Commands

FIRE MISSION, BATTERY ADJUST,
SPECIAL CORRECTIONS, CHARGE
4, DEFLECTION 2942, QUADRANT
370, HC IN EFFECT.

(2) After the observer has completed his adjustment and fire-for-effect firing data have been computed, fire commands will be announced.

Computer's Fire Commands

BATTERY ⑧ ROUNDS, BY ROUND
AT MY COMMAND, SHELL HC,
FUZE TIME, NUMBER 3, TIME
19.7, DEFLECTION 2958, QUAD-
RANT 377; NUMBER 6, TIME 18.7,
DEFLECTION 2935, QUADRANT
357. . . . NUMBER 1, TIME 14.3,
DEFLECTION 2895, QUADRANT
279.

(3) Should there be holes or gaps in the screen, the FO will notify the FDC to re-locate a specific round or adjust the rate of fire for a given point. When placement corrections for a specific point are required, determine subsequent corrections as specified above by the method (manual or FADAC) used in determining the fire-for-effect firing data.

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FM 6-40-5

1 JULY 1976

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

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Major General, United States Army
The Adjutant General

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		6218-01776	

USARPA FORM 944-3 1 JUN 70